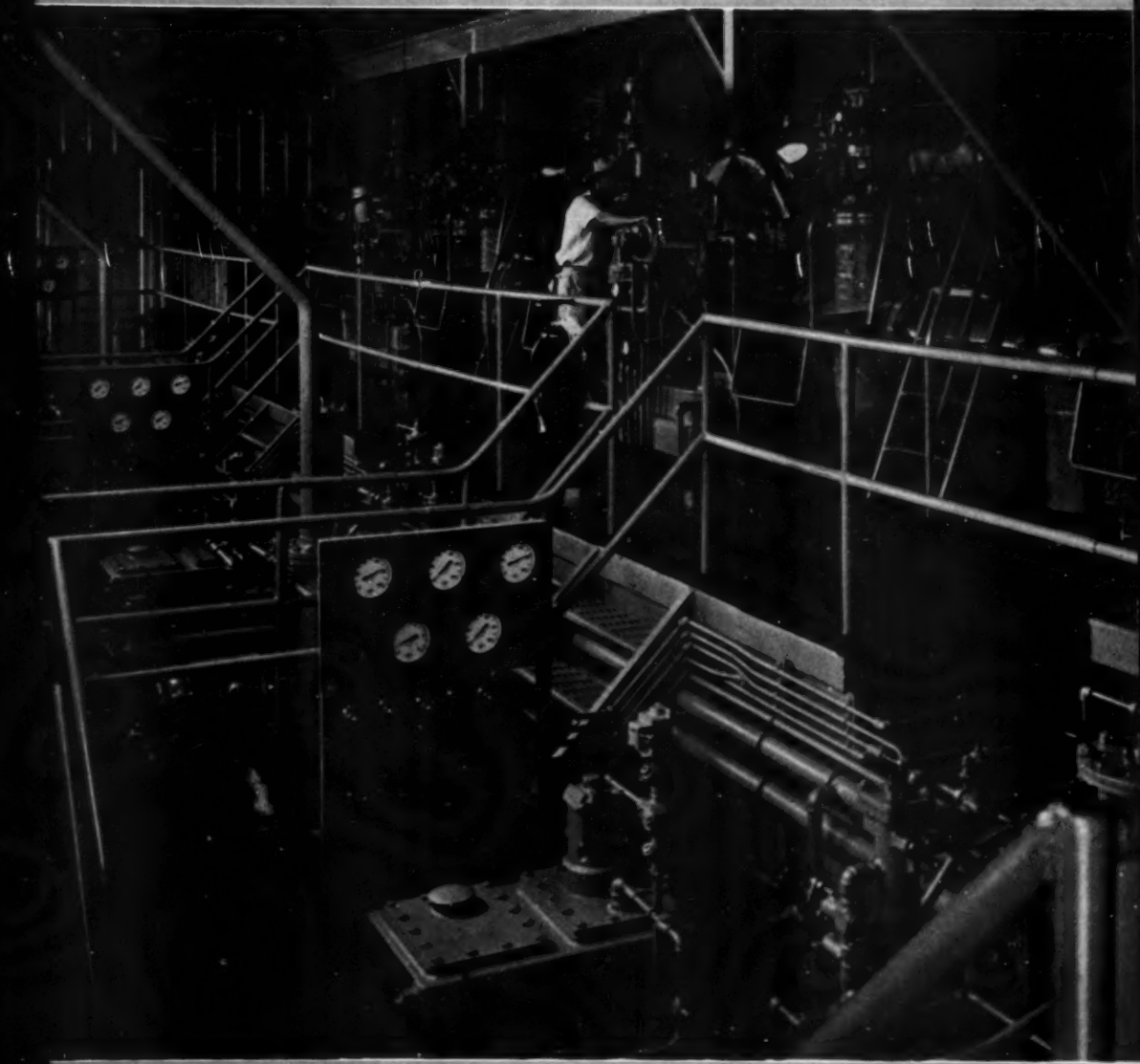
INDUSTRY AND POWER

For Executives and Engineers Responsible For Engineered Plant Services



JULY 1952

Cooperative Steam Plant Serves Five Canneries ..... Page 67

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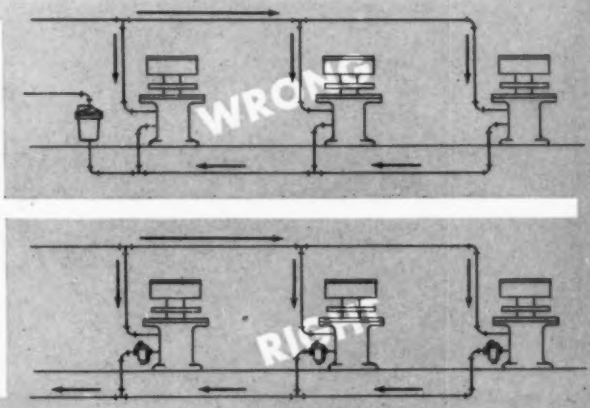
Coordinating Power Breaker Relays ..... Page 100

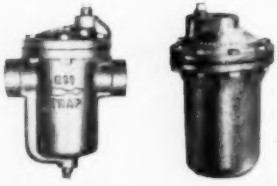
A good trade: How 50 Armstrong traps saved 14 tons of coal per month . . .

User changes from Group Trapping to Unit Trapping

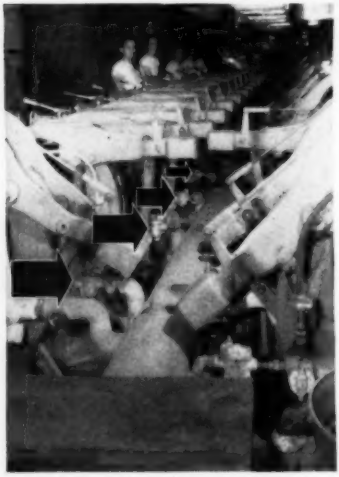
THE drawing labeled "wrong" shows a group of presses drained by a single trap. With this hook-up, condensate and air from one or more presses may fail to reach the trap because even the slightest pressure difference between the units will cause a back flow from a higher pressure unit to a lower pressure unit.

The drawing labeled "right" shows unit trapping, each press drained by a single trap.





Armstrong Steam Traps are available in side inlet-side outlet or bottom inlet-top outlet body styles to best meet your piping requirements.



View of a battery of individually-trapped clothing presses at M. Wile & Company, Buffalo.

AN EXAMPLE of the benefit to be gained from Armstrong Unit Trapping is found in installation at M. Wile & Company, Buffalo, N.Y., clothing manufacturers.

A single steam trap was being used to drain each group of 4 to 6 pressing machines. After changing over to the use of an individual Armstrong trap on each of the fifty presses in the plant, the company reports that, because of the resulting more efficient use of steam, coal consumption dropped by 14 tons a month. There was no reduction in work load. This fuel saving when held up against an investment of about $500 in steam traps was rightly considered *a good trade.*

There are other advantages to Armstrong Unit Trapping. Almost invariably machine temperatures are higher, heat-up is faster and output is increased. The traps themselves are thoroughly reliable, seldom need attention. The design, materials and workmanship in the trap mechanisms for low and medium pressures are identical to those used in Armstrong traps for power plant service at 900 degrees F and 950 lbs. pressure, so they last for a long, long time.

Your local Armstrong Representative will be glad to discuss the savings possible in your plant through Armstrong Unit Trapping. Call him, or write:

ARMSTRONG MACHINE WORKS

820 Maple Street • Three Rivers, Michigan

You Always Get Greater Efficiency When You Use Armstrong Unit Trapping

FREE
44-PAGE
STEAM TRAP BOOK
Gives Complete Details

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820 Maple Street, Three Rivers, Michigan
Please send me a Steam Trap Book.

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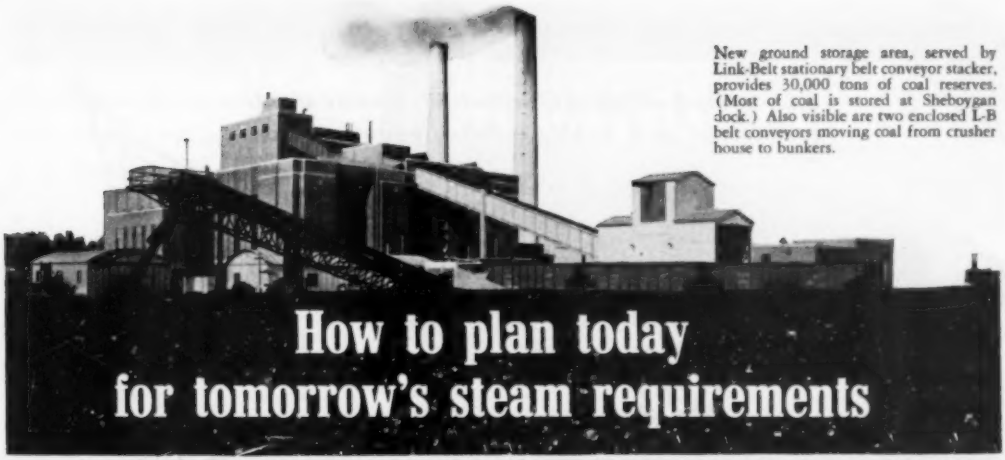
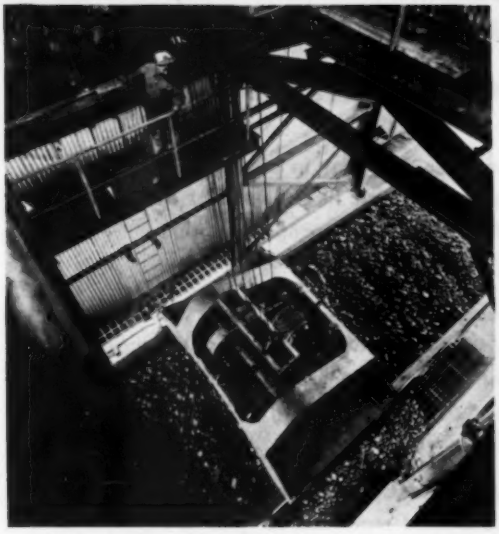
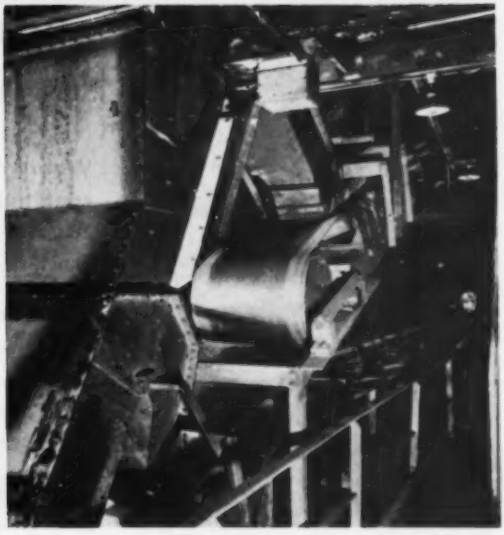


New ground storage area, served by Link-Belt stationary belt conveyor stacker, provides 30,000 tons of coal reserves. (Most of coal is stored at Sheboygan dock.) Also visible are two enclosed L-B belt conveyors moving coal from crusher house to bunkers.

How to plan today for tomorrow's steam requirements



Link-Belt car shaker in coal unloading house expedites unloading of railroad cars. Reciprocating feeders below track hoppers feed belt conveyor leading to crusher house and also stationary stacker.



Unique arrangement for distributing coal to tripper over original bunkers, to inclined belt conveyor leading to new bunkers at higher level, and, through chutes, to front end of original bunkers.

LINK-BELT Coal Handling Equipment, 20 years old, is utilized in 100% expansion of power plant

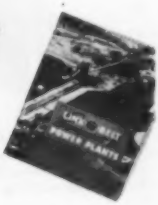
WHEN Link-Belt installed the coal handling system for Wisconsin Power & Light Company's Edgewater Station at Sheboygan in 1931, provision was made by Sargent & Lundy, the consulting engineers, for future expansion. Twenty years later, with a minimum of rearrangement, this plant was enlarged by ⅔. It now efficiently handles 250,000 tons of coal per year.

Link-Belt coal handling equipment is used at other Wisconsin Power & Light plants. Like many power companies all over the country, they rely on Link-Belt to hold rail-to-boiler coal handling costs to a minimum.

A new 44-page book, No. 2410, contains drawings and photographs of many outstanding coal handling systems of all types—large and small. Send for a copy of this useful source book.

LINK-BELT

COAL HANDLING EQUIPMENT



LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices in Principal Cities. 12,000

HEADQUARTERS FOR AIR HANDLING AND CONDITIONING EQUIPMENT

. . . . to meet all types of industrial, power plant, commercial and public building requirements.

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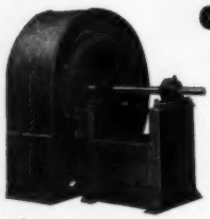

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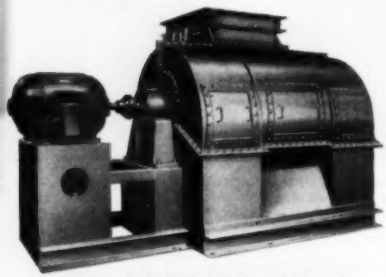

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You can profit by dealing with Clarage. We have an established reputation for getting things done right . . . . As evidence of what we mean, 97 of the 100 largest American corporations are users of Clarage fan equipment. Need we say more?

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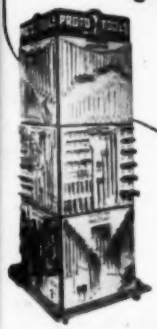
All His Duels...'cause
PROTO means
PROfessional
TOols!



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Acorns of science

Developments not yet available, but of interest to those responsible for Engineered Plant Services

Aluminum Coated Steel

● A process now in the pilot plant stage for producing heat and corrosion resistant coatings on ferrous metals has been developed and described by General Motors Research Laboratories. After a thorough cleaning and pickle, parts are dipped in a preheat salt bath at temperatures from 1280 to 1400 F, and transferred to an aluminum bath covered with ½ in. salt flux for ½ to 1 min. While still red hot, parts are returned to the preheat salt bath and slowly raised to allow cooling. Excess aluminum is removed by airblasting.

Microscopic examination reveals an outer coating of iron bearing aluminum with an intermediate layer, next to the steel, of an iron-aluminum alloy. The corrosion and rust resistant coating may replace zinc in some applications; may be diffused by heat for heat resistance. It may be a continuous process for coating sheet, wire or rod.

Liquid Metal Pump

● The electromagnetic liquid metal pump developed at the Argonne National Laboratory has copper bars soldered or fastened to opposite sides of metal tubing which is placed between poles of an electromagnet. D-c current flowing through the liquid metal develops in it a longitudinal thrust. The pump is capable of handling large quantities of metal at a rapid rate of flow without moving parts.

Process Control By Beta Rays

● Beta ray gages, recently developed for measuring thickness, as of paper, have now been tested as the primary element of an automatic control system for regulating basis weight in paper manufacture. Isotope Products Limited teamed with Bristol Company to link the gage at the wet end of the paper machine with remote control equipment to operate the gate, which regulates flow of material to the machine and therefore basis weight. The sheet is measured from the wire when 80 per cent wet, yet weight variations have been cut as much as half.

Oscillator Controlled Level

● Patent No. 2,590,826 pertains to a system to provide accurate liquid level or liquid density control of reacting fluid. It has no electrical or mechanical contact between the material and control apparatus. The system includes tuned oscillator and amplifier circuits so arranged that the oscillator is at all times under control of a float disposed within the liquid whose level or density is to be regulated.

Neutron Detector

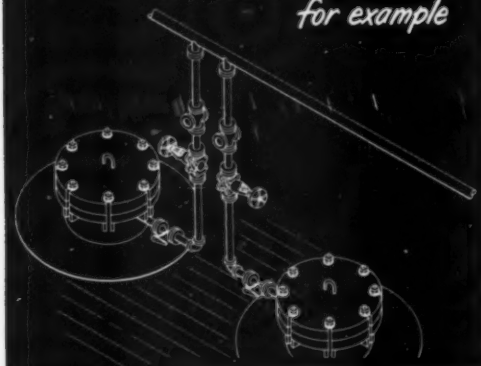
● A possible forerunner of process measuring equipment like the beta ray gage, Patent No. 2,588,789 covers a neutron responsive device comprising a closed tubular glass vessel, the inner surface of which is coated with materials which emit alpha particles when irradiated with neutrons. The vessel contains an ionizable gas and a pair of spaced discharge electrodes, forming an ionization chamber with a neutron activated ionizing coating. One electrode is pointed, the other rounded.

Water Treatment Prediction

● That ion exchange may replace distillation as the principal method of purifying water has been suggested by Arthur D. Little, Inc. It is reported that the first large scale plant, using the new process in which plastic semipermeable membranes and electric power combine to remove mineral salts slated to be built.

Do Your Valves Resist Corrosion Like This?

... on Digester Gases, for example



THE INSTALLATION

VALVE SERVICE RATINGS

CORROSION-RESISTANCE:	Best results ever had
FEATURES:	Plug seating-good for throttling and wide open service
SUITABILITY:	Adopted as standard
MAINTENANCE COST:	No upkeep needed
SERVICE LIFE:	Hardly any wear after 2 years
OPERATING RESULTS:	Better control of digester gases
AVAILABILITY:	Regular Crane Catalog item

Crane Alloy Plug Gate Valves on sulphate digester gas-off service in a large Southern paper mill.

THE HISTORY

Valves in this installation are used to relieve, under throttled flow, the highly corrosive sulphate gases from digesters. Various valves tried gave constant trouble with corrosion, leakage, and difficult operation. Replacements were excessive.

Then Crane 18-8 Mo Alloy Plug Gate Valves were installed on a test basis. After 1 year's service, and again after 2, careful inspection showed hardly a sign of wear or corrosive effects. Meanwhile, the valves operated smoothly; required no maintenance.

So well have Crane valves out-performed and outlasted all others tried, they have been made standard equipment on all digesters.

THE VALVE

One of the leaders in the Crane Alloy line for severe corrosive service—No. 18851 Plug Gate—with 18-8 Mo stainless steel in all parts exposed to flow, including packing gland. Circular, tapered plug seating gives minimum resistance to flow; allows precise control when throttling. Superior design throughout. Flanged or screwed ends. Also in All-Monel. See your Crane Catalog or Crane Representative for full data.

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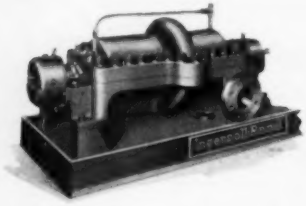
New equipment and developments

Highlights of new products by leading manufacturers

Each new product item has a key number for your convenience in asking for additional, detailed information. Insert key number on return post card on page 131

1—Multi-stage pumps feature improved design

Higher efficiency and improved operation are said to result from design improvements incorporated in class CNTA horizontal, multi-stage centrifugal pumps manufactured by Ingersoll-



Rand Co. Intended for boiler-feed, mine dewatering, refinery and general industrial services to 800 psi, the units are built in 1½, 2, 2½ and 3 in. sizes with 4, 6 or 8 stages. Improvements, including a multiple-volute design, are fully described in a catalog sheet.

2—Belt dressing is packed in spray container

Graton & Knight Co. has announced packaging of Grako Sprazon liquid belt dressing in handy 12 oz containers—enough to treat approximately 350 sq ft of belting. Complete details are given in available literature.

3—Oven panel design is for quick assembly

Electric infrared oven panels to meet the need for ovens that can be built quickly, easily and economically have been designed by Edwin L. Wiegand

Co. The Chromalox panels are complete with built-in bus bars, insulation and frame, ready for erection and connection to plant wiring. Two sizes are available: 1 x 4 ft with capacity of 10.8 kw and 2 x 4 ft with 21.6 kw capacity. Output is in excess of 9200 Btu per sq ft per hr. Construction features are described in bulletin.

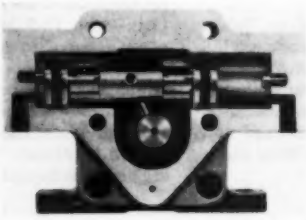
4—Filters are adapted for water filtration

Marvel Engineering Co. has announced production of their synclinal filters for use with water, as well as

hydraulic and low pressure oil systems. Sump types are available in capacities from 5 to 100 gpm and line types from 5 to 50 gpm. Monel mesh sizes are from 30 to 200.

5—Power operated valves have many uses

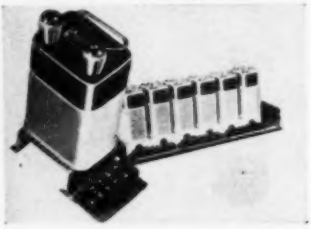
Applications for POV power operated valves manufactured by Ledeen Manufacturing Co. include remote control, automatic operation, reciprocating service and service where failure of electric power or line pressure must reverse the valve. The units are suit-



able for air, oil and water operation. Fluid pressure of the line actuates the valve. Complete information is detailed in a bulletin.

6—Alarm units feature standardized design

Automatic alarm units for remote signalling of abnormal operation of such equipment as valves, pumps and heaters have been developed by Tiger-man-Anderson Co. The Tel-Alarm system consists of self-contained, hermetically sealed units which easily plug into a chassis. Backlighted name-



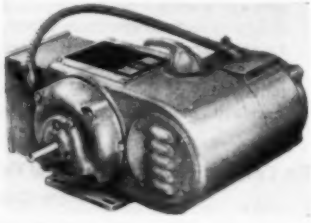
plates or turret lenses for two light systems are available. A brochure presents complete descriptions.

7—Neoprene coatings are for industrial use

Three types of neoprene liquid coatings, known as Mercer-Proco, have been developed by Mercer Rubber Co. Type N-700, an air drying coating for protection against high temperature, steam, acid fumes and splashes, solvents and general wear, can be applied to most surfaces. Type N-600 is used as a skidproof coating. Type N-200 is designed primarily for equipment protection, including heavy immersion service on valves, pumps, pipes, sea valves, and tanks. Literature is available.

8—Variable speed motor is single phase

Single phase variable speed motors in ¼, ⅓, ½ and ¾ hp sizes have been announced by U. S. Electrical Motors

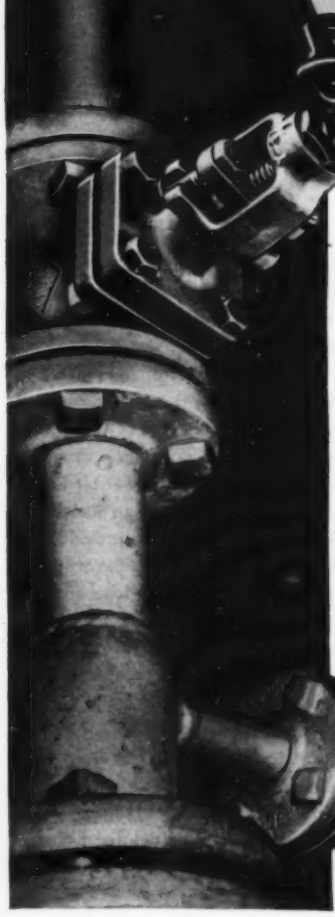


Inc. Designated type VA-C, the units are for 110 or 220 v service. Speeds are provided in a 10:1 ratio with range from 4 to 10,000 rpm. Available bulletin presents complete details.

(Continued on page 12)

Here's the hookup
for valve-killing
corrosive services...

Stainless Steel
PLUS
Jenkins Quality



To end high valve mortality from corrosive liquids, and to control fluids that must be kept free from contamination or discoloration, stainless steel is the right metal. But it takes more than metal to make a valve. For dependable performance, you need the two-way hookup—Stainless Steel *and* Jenkins time-proved Valve Engineering.

With the increased demand for processing equipment that resists corrosion, more and more Stainless Steel Valves have been added to the Jenkins line. It now includes types and sizes to meet most industrial needs.

Look for the famous Diamond trade-mark on valves of stainless steel. As on *any* Jenkins Valve, it means extra years of trouble-free service.

Send for this folder, Form 194, describing the complete line of Jenkins Stainless Steel Valves. It contains specifications and other important data that will help you select the *right* valves for your plant. Jenkins Bros., 100 Park Ave., New York 17, Jenkins Bros., Ltd., Montreal.

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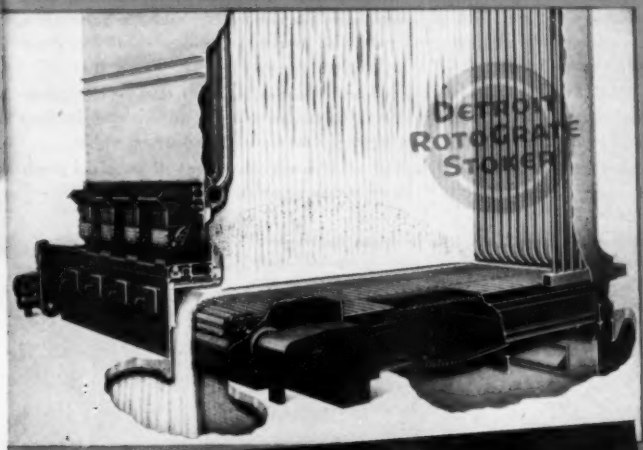

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the biggest dollar value

STOKERS

Detroit RotoGrate Stoker on the line in Prairie Creek Station

REPRESENTATIVE INSTALLATIONS OF DETROIT STOKERS IN PUBLIC UTILITIES

Central States Electric Company
Iowa Falls, Iowa

* **Southern Utah Power Co.**
Cedar City, Utah

Northern States Power Company
LaCrosse, Wisconsin

* **Northern States Power Company**
Mankato, Minn.

Northern States Power Company
Red Wing, Minnesota

* **Central Illinois Electric & Gas Company**
Sabrooke Station: Rockford, Illinois

Ohio Public Service Company
Mahoningside Plant: Warren, Ohio

* **Northern States Power Company**
Sioux Falls, South Dakota

Montana-Dakota Utilities Company
Kincaid, North Dakota

Iowa Public Service Company
Eagle Grove, Iowa

* **Sioux City Gas & Electric Company**
Sioux City, Iowa

Iowa Public Service Company
Storm Lake, Iowa

Central Iowa Power Cooperative
Cedar Rapids, Iowa

* **Indianapolis Power & Light Company**
Indianapolis, Indiana

Montana-Dakota Utilities Company
Beulah, North Dakota

Corn Belt Power Cooperative
Humboldt, Iowa

* **Black Hills Power & Light Company**
Osage, Wyoming

Minneapolis Street Railway Company
Minneapolis, Minnesota

Mississippi Valley Public Service
Winona, Minnesota

* **Iowa Public Service Company**
Waterloo, Iowa

Montana-Dakota Utilities
Mobridge, South Dakota

Montana-Dakota Utilities Co.
Sheridan, Wyoming

Prairie Creek Power Station
Operated by Iowa Electric Light & Power Co.

Iowa Southern Utilities Company
Bridgeport Station: Eddyville, Iowa

* **Central Illinois Electric & Gas Co.**
Fordham Station: Rockford, Illinois

* *Repeat orders.*

New equipment and developments

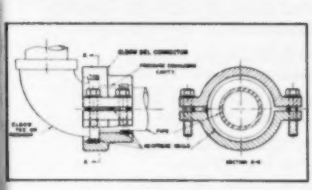
(Continued from page 8)

9—Roller chain incorporates oil-impregnated bushing

Roller chains have been developed by Whitney Chain Co. for applications where conventional lubrication methods are neither possible nor desirable. Incorporating an oil-impregnated sintered metal bushing, the chain is said to require little or no lubrication.

10—Connectors permit emergency pipe repairs

Leaks in piping can be sealed or units of piping for temporary lines can be quickly joined by use of the Bel Con-



nector developed by Holoal Manufacturing Corp. A cavity around the leak equalizes pressure on both sides of the break to prevent its extension. All contacts with the pipe are sealed with neoprene. Applications include hot and cold water, steam, fuel oil, and gasoline with pressures to 150 psi.

11—Relay provides positive phase protection

Positive phase protection for polyphase rotating machinery is provided by a phase sequence relay introduced

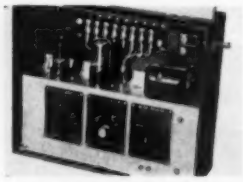
by The Shepard Elevator Co. The unit operates on either 2 or 3 phase current and is available in most voltages and frequencies.

TO REQUEST ADDITIONAL FREE DATA

Insert " key" numbers on return post card found on page 131. Our Reader's Service Department will handle your request promptly

13—Humidity control is for process or comfort

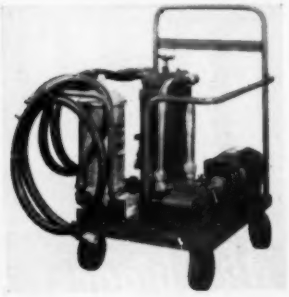
Two-position or proportioning control of humidifying or dehumidifying processes is possible with an electronic humidity control developed by Barber-



Colman Co. High sensitivity, instant response, wide range and simple adjustments are featured.

14—Filter unit is portable

J. N. Fauver Co. has developed a two stage portable transfer unit for filtration of hydraulic oils in machine tools. The unit consists of a Yale &



Towne pump and two Cuno filters. Said to filter out everything to 25 microns, it has a capacity of 10 gpm.

15—Tape provides moisture vapor barrier

Development of an industrial pressure sensitive tape said to be almost 100 per cent waterproof has been announced by Polyken Industrial Tape Dept. of Bauer & Black. The product meets government specifications for type I, grade A. A file card is available describing six government specifications and the tapes which meet them.

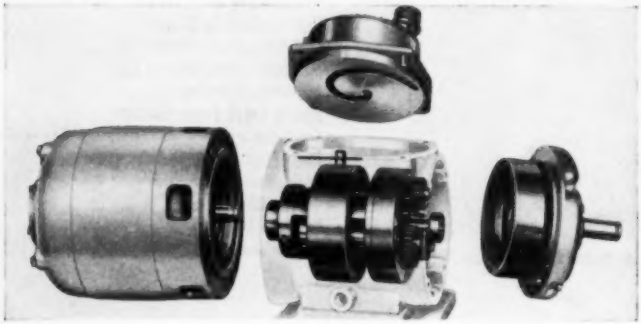
16—Swivel joints are self-aligning

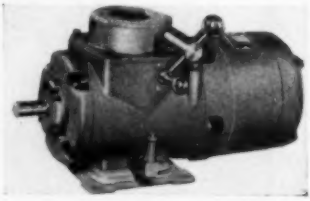
Self-aligning, high pressure hydraulic swivel joints for general industrial applications have been developed by Barco Manufacturing Co. The units

(Continued on page 16)

12—Variable speed unit allows close resetting

Variable speed transmissions for low horsepower applications at 1800 rpm input have been designed by Graham Transmissions, Inc. Speed ranges are from any desired maximum to zero with hairline accuracy of speed holding and ability to reset exactly to a desired speed. If overloading occurs, the drive





can be stalled for prolonged periods without damage. Designated model 18, the units are available with or without motor and with standard output or built-in worm, single or double stage helical spur reduction. A compound planetary gear system is used with a non-rotating traction ring. The ring engages two or more tapered rollers at varying diameters to produce speed changes. Traction is obtained by centrifugal force on the rollers.

JACK FROST

at 406° F.

MAGNIFIED fifty times, the calcium carbonate scale in the photo above might easily be mistaken for a frosted window pane. It was formed at 250 p.s.i. in one of the Nalco Laboratories' test boilers as a part of the continuing Nalco research program, aimed at keeping such scales *out* of your power plant equipment.

Whether your feedwater and plant conditions produce this type of scale — or any of hundreds of others — your Nalco Representative has the proved solution for eliminating scale or corrosion from raw water inlet to and through condensate return lines . . . permanently . . . economically. Check with him today — or write direct for fast action on your water treatment problems.

DO YOU RECEIVE "Nalco ABSTRACTS"?

"Nalco ABSTRACTS" is a quarterly publication containing abstracts of general and technical articles of interest to power plant engineers. If you, like most of us, find too little time to read, "Nalco ABSTRACTS" can be of real help in keeping you up-to-date on current developments. Your copies will be sent free upon request.

NATIONAL ALUMINATE CORPORATION
6218 W. 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to
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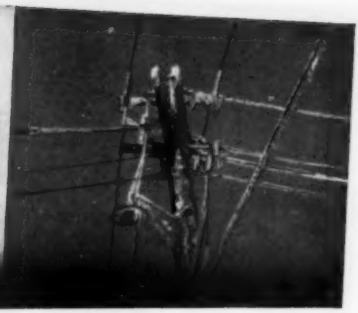
THE *Nalco* SYSTEM...Serving Industry through Practical Applied Science



When an

ICE STORM CAUSED SINGLE PHASING

and low voltage conditions . . we blew a flock of Fusetron fuses but we saved over 40 motors from burnout

"For twenty-four hours after the bad ice storm of February 15, 1950 we were endangered by single phasing and low voltage conditions due to the damage done the power lines by the ice.

"During this period, we blew a flock of Fusetron dual-element fuses—around 240 in fact—but we figure that was a very cheap price to pay for saving over 40 motors from burning up.

"After this experience we didn't lose any time in putting all of our plant and equipment under Fusetron Fuse protection."

Michael G. Kupcho,
Master Mechanic
Ashland Shirt and Pajama Company
Ashland, Pennsylvania

You too, can be safe from electrical hazards by using

Fusetron Fuses

They provide 10 Point Protection

1 *Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

*Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

It migh
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Mabel Rohrle

"Obtainin
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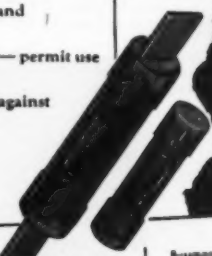


FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

DON'T RISK LOSSES IN YOUR PLANT

Delay may cost you more than replacing every ordinary fuse with a FUSETRON dual-element Fuse — but by passing the word along that all purchase and stock records should call for FUSETRON dual-element fuses, you have action that begets money saving.

SEND THE COUPON FOR MORE FACTS

Bussmann Mfg. Co., University at Jefferson, St. Louis 7, Mo. (Division of McGraw Electric Co.)

Please send me complete facts about FUSETRON dual-element Fuses.

Name _____ Title _____

Company _____

Address _____

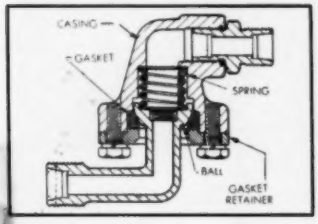
City & Zone _____ State _____ 752

(FUSETRON is a trade mark of Bussmann Mfg. Co., Division McGraw Electric Co.)

New equipment and developments

(Continued from page 12)

provide 360 deg swivel action and up to 15 deg side flexibility. Sizes for ¼, ⅜, ½, or ⅝ in. tubing or equivalent size pipes are available with straight or



angle connections. Pressure rating is 3000 psi for temperatures ranging from -100 to 500 F. Construction details are presented in 4-page bulletin.

17—Valves control cylinder position

Spring centered neutral valves designed to stop and hold single or double acting cylinders in any position have been announced by Valvair Corp. In neutral position all ports are blocked. Knob, lever, foot, clevis, double acting cylinder and double acting cylinder with pilot valve styles are available for three or four way piped exhaust types.

For control of air, water, oil or inert gas, they are made in ¼, ⅜, ½, ¾, and 1 in. sizes. Literature is available.

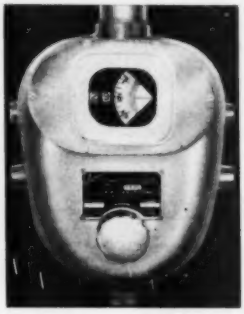
18—Resistor is for high current duty

Powr-Rib edgewound-type resistor designed for high current duty has been announced by Ohmite Manufacturing Co. Advantages listed include high heat dissipation, resistance to oxidation and ability to withstand shock and vibration. Units are available in re-

sistance values from 0.100 to 2.85 ohm, and are rated at 375 C temperature rise on the ribbon. Capacities range from 18.0 to 108 amp. Literature is available.

19—Tank gage eliminates counterweight

Automatic liquid level gage, No. 2500, developed by The Vapor Recovery Systems Co. for low pressure storage



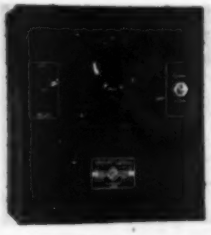
tanks, does not require a counterweight to maintain constant tape tension. Other features include a counter for reading foot increments and a dial for reading inches, in fractions, of tank content.

TO REQUEST ADDITIONAL FREE DATA

Insert " key" numbers on return post card found on page 131. Our Reader's Service Department will handle your request promptly

20—Variable speed control requires no warm-up

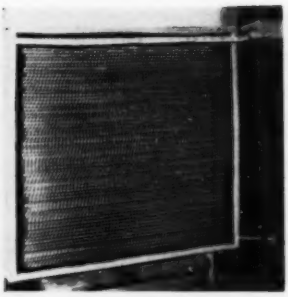
Variable speed motor control, designed by General Radio Co. for ¾ hp motors, uses no electronic tubes and therefore requires no warm-up time. Instant starting and reversing is pro-



vided as well as strong dynamic braking. The unit, type 1702-A Variac, is fully described in a bulletin.

21—Air filter traps fine particles

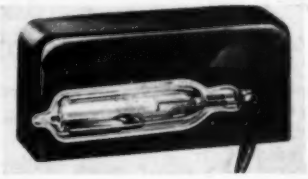
Mine Safety Appliances Co. announces availability of its Ultra-Aire space filter for general industrial applications. Originally developed for removal of radioactive contamination from air, the unit is certified to be at least 99.95 per cent efficient against particles as small as 0.3 micron, according to the manufacturer. For use in either the intake or exhaust of air con-



ditioning systems, it is available in 50, 500 and 1000 cfm sizes. Suggested applications are listed in data sheet.

22—Mercury switches are shock resistant

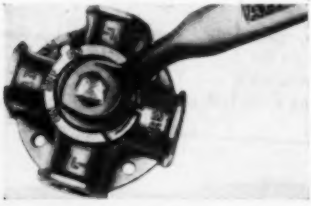
Mercury switches embedded in plastic potting compounds have been developed by Micro Switch, division of



Minneapolis-Honeywell Regulator Co. Additional protection against shock is provided, as well as gaining a new means of mounting. Numerous designs are offered. Illustrated is the IMPI unit; rated 2 amp, 115 v a-c or 1 amp, 115 v d-c.

23—Valve has many applications

Control of air, water, oil, vacuum and various gases up to 150 psi for gases and 200 psi for liquids are listed as applications for an inexpensive 4-way

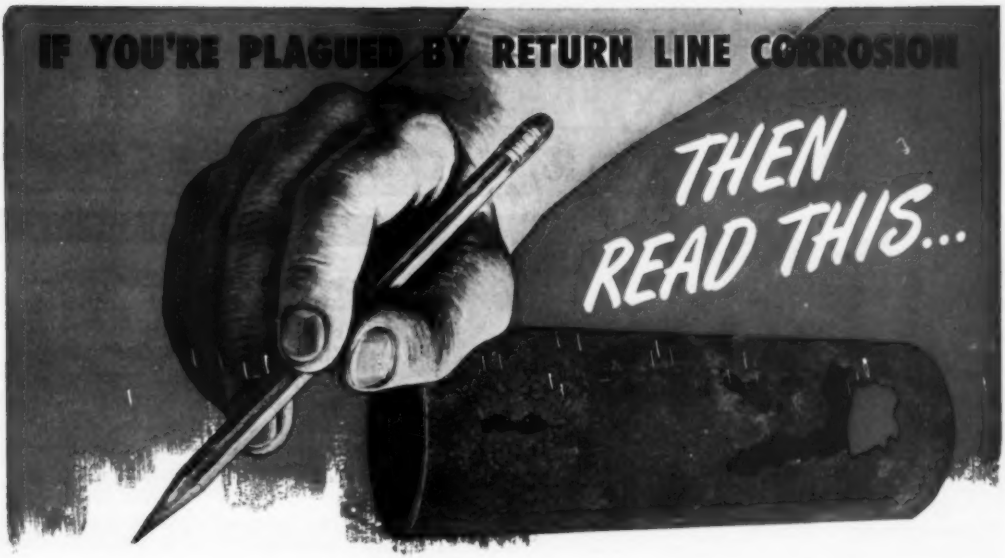


valve produced by Ardee Manufacturing Co. Available literature outlines construction features and advantages.

24—Copper compound does not form precipitates

Cuprogen, a combination of copper sulfate and an organic sequestering agent developed by Miami Products & Chemical Co., is said not to precipitate

(Continued on page 20)



As an engineer responsible for efficient, economical plant operation, you know only too well that corrosion of steam and condensate lines can send costs skyrocketing through pipe replacement, interrupted production, and increased labor and maintenance. Perhaps you, like many other engineers, have tried stop-gap methods to check the problem only to find them partially effective or far too costly.

Realizing the importance of this major industrial problem, Betz Laboratories has developed its patented filming amine treatment. Here, at last, is a simple, inexpensive, and practically 100% effective method of eliminating this costly and production-disrupting headache.

For example, a linoleum company, operating at 150 psi and producing 300,000 pounds of steam per day, employed sodium zeolite softening for a high bicarbonate raw water. The carbon dioxide content of the steam averaged 40 ppm. Continued maintenance was required due to failure of condensate lines from the steam kettles and unit heaters. After the filming amine treatment was applied, maintenance records showed an annual saving of approximately $8,000.00! And, a large part of this saving was obtained by eliminating weekend over-time work on pipe replacements.

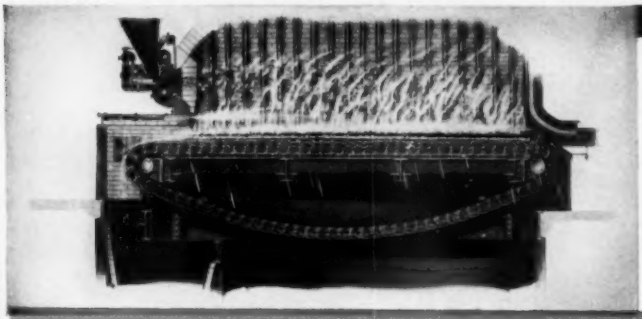
Why not take the first step toward ridding your plant of corrosion *now?* Call in a Betz Engineer. Ask him to show you how Betz *Specialized* Water Conditioning Service can help you . . . quickly . . . economically . . . effectively. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: Betz Laboratories Limited, Montreal 1.

See for yourself how Betz filming amine treatment eliminates return line corrosion and reduces operating costs. Send for Technical Bulletin No. 124.

BETZ

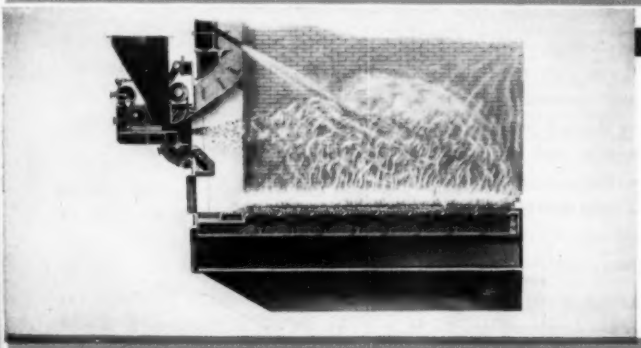
CONSULTANTS ON ALL WATER PROBLEMS

ERIE CITY
FOR YOUR SPECIFIC



"TRAVAGRATE"

In the "Travagrate," flexibility, to handle widely varying load demands, is combined with ruggedness. The Erie City "Triple Feeder" and distribution controls assure accurate fuel spreading over the moving grate. Our latest bulletin, which is offered in the convenient coupon below, shows in detail these and many other features.



DUMPING GRATE

The Erie City Dumping Grate Spreader uses the same "Triple Feeder" and Fuel Distribution system as the "Travagrate." All stoker parts exposed to furnace heat are made from a special heat resisting alloy iron in our own foundry. When required, parts of Erie City Spreader Stokers exposed to furnace heat are air and water cooled.

UNDERFEED RAM TYPE SIDE DUMP STOKER

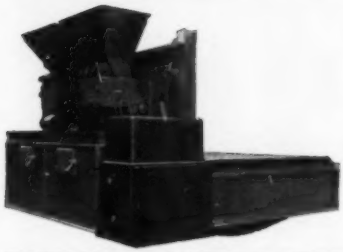
There is an Erie City Single-Retort Underfeed Stoker for practically every type of boiler to handle steam loads up to 700 developed boiler horsepower. These stokers are furnished in low-set and heavy-duty models. Our bulletin gives details and illustrates various applications.

ERIE CITY IRON WORKS

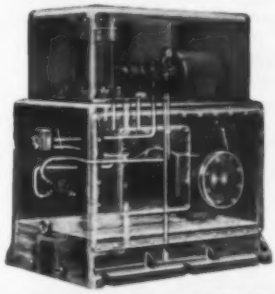
STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED and SPREADER STOKERS • PULVERIZERS

STOKERS
REQUIREMENTS

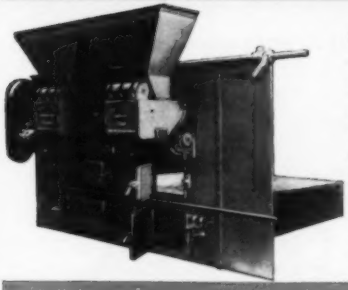
CONTINUOUS ASH DISCHARGE SPREADERS



The Erie City Hydraulic Drive unit is completely housed in an oil-tight unit without external piping. The fluid drive transmits power to the main shaft through a linkage and ratchet gear. A single control valve regulates grate speed.



TYPE SPREADER STOKERS



Grate units are interchangeable and easy to remove or replace. The bulletin offered below fully describes how dumping grates are connected to dumping bars which are actuated for ash disposal by power cylinders — either steam or air powered. A 4-way hand operated valve is located on the lower front to the right of each ash door.

You can study the design and construction of Erie City Stokers by simply filling in the handy coupon below. As a designer and manufacturer of dependable steam generating equipment for over 112 years, we believe you will discover that Erie Stokers reflect this experience. If you use coal we want you to know Erie City Stokers regardless of whether you plan new power, process, or heating installations. These stokers were designed to meet the exacting needs of industry in the efficient production of steam. If you wish to consult with an Erie City engineer or obtain copies of our stoker literature, let us know by mailing the coupon below.

Erie, Pa.

ERIE CITY IRON WORKS
ERIE, PA.

Gentlemen:

☐ We are interested in seeing your stoker bulletin: ☐ Underfeed ☐ Spreader.

☐ We would like to discuss Stokers with an Erie City engineer.

NAME_____

TITLE_____

COMPANY_____

CITY_____ STATE_____

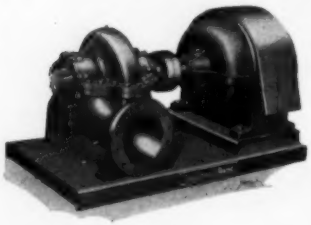
New equipment and developments

(Continued from page 16)

in hard water. Used for control of many forms of algae, fungi and slime, it is suggested for use in conjunction with cooling towers and other industrial equipment.

25—Pumps use sealed ball bearings

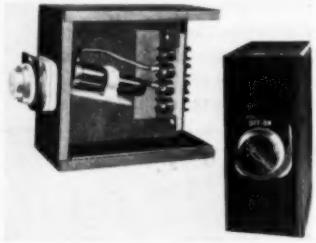
Double mechanical shaft seals with sealed, pre-lubricated ball bearings have been incorporated in class DMV-DHV single stage, double suction pumps



manufactured by Ingersoll-Rand Co. The result is said to be a compact, totally enclosed unit requiring minimum maintenance. Built in 3, 4, 5 and 6 in. sizes, the pumps are for general hydraulic services up to 200 F, 2100 gpm and 150 psi.

26—Switch is designed for explosive locations

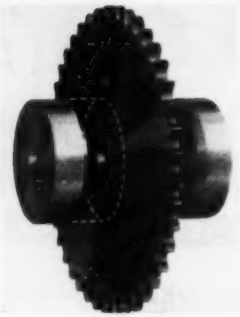
Development of a mercury safety switch for positive safety in hazardous, explosive locations has been announced



by Tigerman Engineering Co. For vertical panel mounting, the unit is single pole for single or double throw action. Push-button or selector switch styles are available.

27—Stock items make up sprockets

Semi-stock sprockets, developed by Cullman Wheel Co., are said to convert made-to-order sprockets into stock items. Type B or type C sprockets are made by welding one or two hubs to



a type A sprocket. Finish-machining and bore sizing complete the unit to specifications. Various pitches and number of teeth are available. Details are presented in a 12-page catalog.

TO REQUEST ADDITIONAL FREE DATA

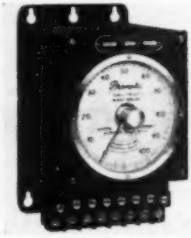
Insert " key" numbers on return post card found on page 131. Our Reader's Service Department will handle your request promptly

28—Motor incorporates built-in heat exchanger

The Reliance Electric & Engineering Co. has developed a totally enclosed, dual cooled d-c motor to meet the need for enclosed adjustable speed drives in relatively large horsepower ratings. A heat exchanger, incorporated as an integral part of the frame, employs internal and external fans powered independently by a 1½ hp, 3 phase, 60 c motor. Units to 150 hp are available.

29—Instrument controls timed operations

General Control Co. has announced the Promatic electronic timer for controlling timed operations between 60



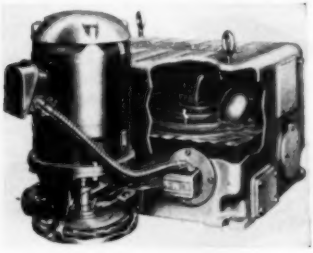
millisec and 60 sec. An indicator is used to manually set time period. Supply current is 115/220 v, 60 c.

30—Tape is for heavy duty work

Plastic electrical tape developed by Van Cleef Bros., Inc., a division of Johns-Manville Corp., is said to be particularly adapted to heavy duty work. It is .010 in. thick, has high strength and flexibility, and is resistant to weather, oils, acids, alkalies and corrosive chemicals. Dielectric strength averages 10,000 v.

31—Condensation pump is compact

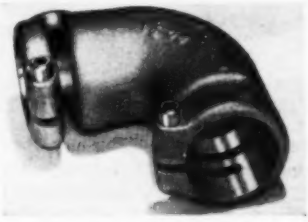
Single and duplex condensation pumps, developed by Hoffman Specialty Co., consist of pump, motor and cast iron receiver assembled as a compact unit. Known as type C, the units incorporate a vertical, close-coupled centrif-



ugal pump using a split type packing gland. Capacities to 225 gpm are listed. Illustration shows type CS single unit. Construction details are described in 8-page bulletin.

32—Fitting eliminates threading or welding

Stainless steel fittings for joining pipe or tube without threading or welding have been developed by The Cooper Alloy Foundry Co. Known as Quikupl, they are suited for service up to 150 psi. In addition to being quickly assem-



bled, the fittings eliminate the need for heavy tube walls since threading is not required. Complete description is contained in available literature.

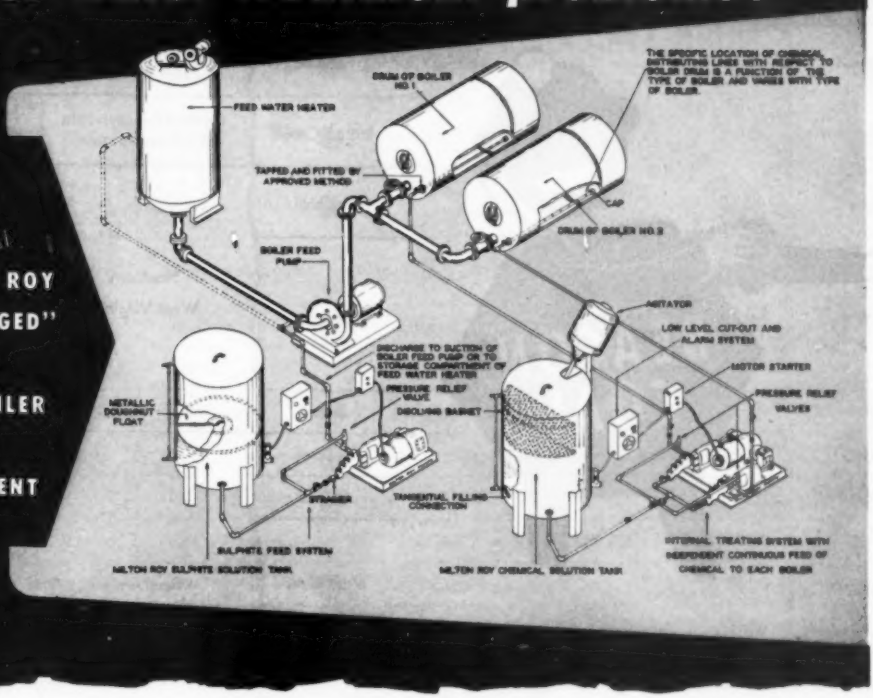
33—Sheeting is for corrosion protection

Roll sheeting, developed by Rubber & Plastics Compound Co., Inc., is said to combine the outstanding properties of its components. Consisting of spun glass, synthetic rubbers and asphaltic hydrocarbons, it provides high tensile strength and resistance to moisture, oxidation, corrosion and climatic changes. Applications include waterproofing and corrosion protection of structural steel, reinforced concrete, tanks, tunnels and pipelines.

(Continued on page 24)

Here's a sure "system" for beating boiler water treatment problems!

IT'S A TYPICAL MILTON ROY "PACKAGED" SYSTEM FOR BOILER WATER TREATMENT


FEED WATER HEATER
DRUM OF BOILER NO.1
TAPPED AND FITTED BY APPROVED METHOD
DRUM OF BOILER NO.2
BOILER FEED PUMP
AGITATOR
LOW LEVEL CUT-OUT AND ALARM SYSTEM
MOTOR STARTER
PRESSURE RELIEF VALVES
METALLIC DOUGHNUT FLOAT
PRESSURE RELIEF VALVE
DISCHARGE TO SUCTION OF BOILER FEED PUMP OR TO STORAGE COMPARTMENT OF FEED WATER HEATER
STRAINER
TANGENTIAL FILLING CONNECTION
SULPHITE FEED SYSTEM
MILTON ROY SULPHITE SOLUTION TANK
MILTON ROY CHEMICAL SOLUTION TANK
INTERNAL TREATING SYSTEM WITH INDEPENDENT CONTINUOUS FEED OF CHEMICAL TO EACH BOILER

IN these days of insistence on production efficiency, engineers turn to Milton Roy for *dependable* continuous treatment of boiler feed water. Here are just a few reasons why:

Milton Roy automatic "packaged" systems are engineered by specialists in Controlled Volume Pumping. The use of Milton Roy Controlled Volume Pumps in these systems is positive assurance of precision control and metering of chemicals at any pressure requirement. The patented non-clogging liquid end step-valve design of these pumps contributes materially to the efficiency of the system. Power plants and public utilities, both large and small, attest the record of uninterrupted service supplied by Milton Roy pumps and equipment.

These packaged systems are custom engineered to specifications. All necessary accessory equipment is supplied—solution tanks, covers, gage glasses, low-level cut-outs and alarms, motor starters and agitators as needed. Obvious benefits result from using one source of supply.

Milton Roy supplies systems for internal and external water treatment to handle all treating chemicals to meet all capacity and pressure requirements. Write to our engineers for complete information.

WITH THE EXCLUSIVE STEP-VALVE DESIGN

MILTON Roy COMPANY

1319 EAST MERMAID LANE, PHILADELPHIA 18, PA.

MANUFACTURERS OF CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

Ready FOR ANY FUEL JOB

NAME OF COAL	CHARACTER	MINE
Sonman	Central Pennsylvania Low Volatile	Sonman
Indian Creek	Central Pennsylvania Medium Volatile	Melcroft
Federal	Northern West Virginia	Federal #1
Bergoo		Bergoo #2
		Bergoo #4
		Bergoo #6
Blair		Balair
Eccles	Southern West Virginia Low Volatile	Eccles #5
		Eccles #6
Helen		Helen #9
New River		Stotesbury #8
		Stotesbury #11
Caswell		Caswell
Pocahontas		Keystone
		Maitland
Beards Fork	Southern West Virginia and Eastern Kentucky High Volatile	Beards Fork
Page		Page
Kopperston		Kopperston #1
Nora Gas		Kopperston #2
Powellton		Powellton #3
Wharton		Wharton #1
		Wharton #2
Weeksbury		Weeksbury

There's never any need for compromising on the fuel properties you require for your particular combustion job, when you use Beacon Coal. You'll find, in this comprehensive line, a fuel that's exactly suited to each application: domestic hand and stoker fired; commercial hand or stoker fired; general industrial; electric utilities; railroad; steamship bunker; coke and gas plants; and special uses. Mine locations and shipping facilities, as shown on the chart, permit the most advantageous distribution. And finally, the conveniently located sales offices bring the able services of Beacon representatives within easy reach.

Want a copy of this chart for your fuel file?

If you'd like one of these ready-reference charts for file . . . just drop a line to the nearest office.

EASTERN GAS AND FUEL ASSOCIATES
BEACON COAL

EASTERN
PITTSBURGH · BOSTON

This convenient Reference Chart shows why!

SEAM	COUNTY & STATE	RAILROAD	DIS-TRICT	SIZES MADE	DAILY PROD. TONS	NAME OF COAL
"E"	Cambria (Pa.)	Penna.	1	Lump; Slack; M/R; N&S; Stoker	2500	Son[illegible]n
"B" or Miller	Fayette (Pa.)	B & O	1	M/R; N&S; Slack	1200	Indian[illegible]reek
Pittsburgh	Marion (W. Va.)	Monongahela; B&O	3	Stoker; Lump; Egg; Nut; N&S; Slack; M/R	10,000	Fed[illegible]l
Sewell	Webster (W. Va.)	Western Maryland	3	Lump; Egg; Jr. Egg; Nut; Stoker; Buckwheat; Slack; N&S	1500	
Sewell	Webster (W. Va.)	Western Maryland	3	Lump; Egg; Jr. Egg; N&S; M/R	1600	Be[illegible]o
Sewell	Webster (W. Va.)	B & O	3	Lump; Egg; Nut; Slack; M/R	1000	
Fire Creek	Webster (W. Va.)	B & O	3	Egg; Nut; N&S; M/R	2000	B[illegible]
Beckley	Raleigh (W. Va.)	C&O; Virginian	7	Egg; Stove; Nut; N&S; Slack	2000	Be[illegible]y
Sewell	Raleigh (W. Va.)	C&O; Virginian	7	M/R; N&S; Slack	1000	Se[illegible]l
Pocahontas #3	Raleigh (W. Va.)	C&O; Virginian	7	Stove; Nut; N&S; Slack	2500	
Pocahontas #4	Raleigh (W. Va.)	C&O; Virginian	7	Stoker; M/R; Slack	2000	New[illegible]er
Pocahontas #4	Raleigh (W. Va.)	Virginian	7	M/R; Slack	1800	
Pocahontas #3	McDowell (W. Va.)	N & W	7	Stoker; Egg; Stove; Nut; N&S; Slack; M/R	2500	
Pocahontas #3	McDowell (W. Va.)	N & W	7	Stoker; Egg; Stove; Nut; N&S; Slack; M/R	5000	Poca[illegible]ntas
Pocahontas #4	McDowell (W. Va.)	N & W	7	Stoker; M/R; Slack	1500	
Eagle	Fayette (W. Va.)	Virginian	7	M/R	1500	
Eagle	Fayette (W. Va.)	Virginian	7	M/R; N&S	1000	E[illegible]e
Eagle	Wyoming (W. Va.)	Virginian	8	Slack; N&S; M/R	3000	
Campbells Creek	Wyoming (W. Va.)	Virginian	8	Slack; N&S; M/R	3500	No. [illegible]Gas
Powellton & Eagle	Fayette (W. Va.)	C & O	8	N&S; M/R	2000	Pow[illegible]ton
Hernshaw	Boone (W. Va.)	C & O	8	Lump; Egg; N&S; M/R	3500	Wh[illegible]ton
Hernshaw	Boone (W. Va.)	C & O	8	M/R; N&S	2500	
Elkhorn #3	Floyd (Ky.)	C & O	8	Block; Egg; Slack; M/R; N&S	1000	We[illegible]bury

GAS AND FUEL ASSOCIATES

CHICAGO • CLEVELAND • DETROIT • NEW YORK • PITTSBURGH • PHILADELPHIA • BOSTON

For New England: New England Coal & Coke Company, 60 Batterymarch Street, Boston, Mass.

New equipment and developments

(Continued from page 20)

34—Fan is designed for high efficiency

Higher efficiency—over 90 per cent—and a reduction in noise intensity level are claimed by the manufacturer, Sturtevant Div. of Westinghouse Elec-

trict Corp., for a non-overloading centrifugal fan. Incorporating new blade design and aerodynamic changes in inlet and casing, it is designed for industrial and power applications up to 600,000 cfm. Wheel sizes are from 40¼ to 108¾ in. diam.

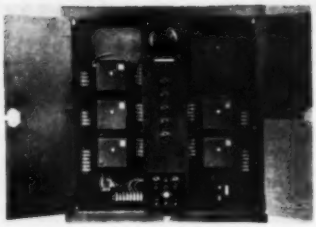
35—Diffuser provides humidity and temperature control

Automatic control of the volume of conditioned air as a means of controlling temperature and humidity is pos-

sible with Flexiflo type A air diffuser developed by Universal Diffuser Corp. The unit is designed for use in conjunction with a thermostat and humidistat.

36—Combustion safety control is centralized

Centralization of combustion safeguard equipment for 2 to 16 burners can be accomplished with Protect-O-Glo system introduced by the Industrial Div. of Minneapolis-Honeywell Regulator Co. A flame detector and relay circuits act to shut off fuel supply in



the event of flame failure. Operating options available include sequence, unison or independent light-off.

37—Unit deaerates water at low temperature

Removal of oxygen and free carbon dioxide from water to prevent harmful effects of corrosion is possible with a vacuum deaerator developed by The Permutit Co. The unit is especially designed for applications where water is to be used cold, since the boiling point is lowered by carrying out the process under vacuum.

TO REQUEST ADDITIONAL FREE DATA

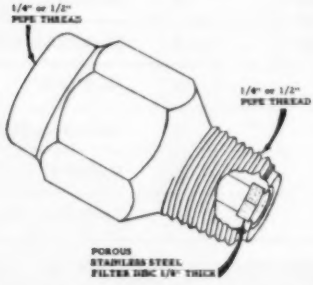
Insert " key" numbers on return post card found on page 131. Our Reader's Service Department will handle your request promptly

38—Purge meter features multiple tubes

Development of a multiple tube purge meter, the Brooks-Mite, has been announced by Brooks Rotameter Co. Available in 2, 4 or 6 tube units, they replace a similar number of single tube meters or bubblers for metering and regulating small flows of liquids or gases. Common manifold or individual inlets are available. Construction details are presented in a bulletin.

39—Snubbers use porous stainless steel disc

Gage snubbers utilizing a porous stainless steel disc for damping pulsating pressures have been redesigned



for high pressure service. Manufactured by Equipoise Controls, Inc., they are available in ⅛ or ½ in. pipe thread sizes for operating pressures to 20,000 psi. The units can also be used as filters or as orifices to filter or maintain small rates of flow.

40—Panel instrument line includes four models

The Foxboro Co. has announced the Consotrol series of compact indicators, recorders and controllers. Included are: model 52 controller featuring a 4 in. in-

dicating scale and continuous valve position indicator; model 53 recorder, illustrated, employing a 4 in. strip chart to provide a continuous 30-day process record; model 58 controller which permits adjustment of a proportional band from zero to infinity and adjustable reset time over a 1000:1 range; and model 59 controller which is mounted directly on a valve motor to control liquid flow. Complete descriptions are contained in a bulletin.

41—Regulator is redesigned for greater accuracy

Design modifications of a low-cost, direct-acting flow rate regulator manufactured by W. A. Kates Co. are said to provide greater accuracy and improved performance on all liquid flow control problems. Said to be accurate

within plus or minus 3 per cent, the units are available in capacities from 0.1 to 100 gpm.

42—Valve incorporates time delay

Automatic Switch Co. has developed a solenoid shut-off valve incorporating a time delay mechanism to hold back flow of liquid or gas for approximately 5½ sec after solenoid is energized. Applications include use with oil burners—the oil being held back until suffi-

(Continued on page 28)

ALOYCO valves cut installation and maintenance costs

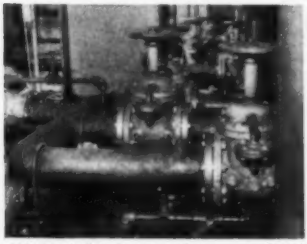
THE CORROSIVE: Ammonium nitrate solution.

THE APPLICATION: Manufacture of prilled ammonium nitrate fertilizer.

THE PLACE: Spencer Chemical Company, Pittsburg, Kansas.

THE VALVES: Sixty-four ALOYCO No. 1105 stainless steel steam jacketed gate valves.

THE RESULTS: Former valves were unsatisfactory due to hot spots caused by improper insulation and nigh maintenance costs. Replacement with ALOYCO valves has cut the cost of expensive fabrication of steam tracing which is not satisfactory for efficient operation. Performance of ALOYCO valves has been extremely good, with no evidence of freezing, corrosion or leaks.



ALOYCO jacketed gate valves were selected for this new process to meet both cost and performance requirements.

THE BACKGROUND: ALOYCO's entire manufacturing and engineering services are devoted to the production of corrosion-resistant alloys.

All our facilities are directed toward reducing valve costs, lengthening valve life in corrosive services. It is no wonder more ALOYCO corrosion-resistant valves are used than any other brand.

Whenever your manufacturing or processing problem can be solved by a corrosion-resistant valve, let our *Aloyco Corrosion Clinic* work with you.

ALLOY STEEL PRODUCTS CO., INC.
1306 West Elizabeth Avenue, Linden, N. J.

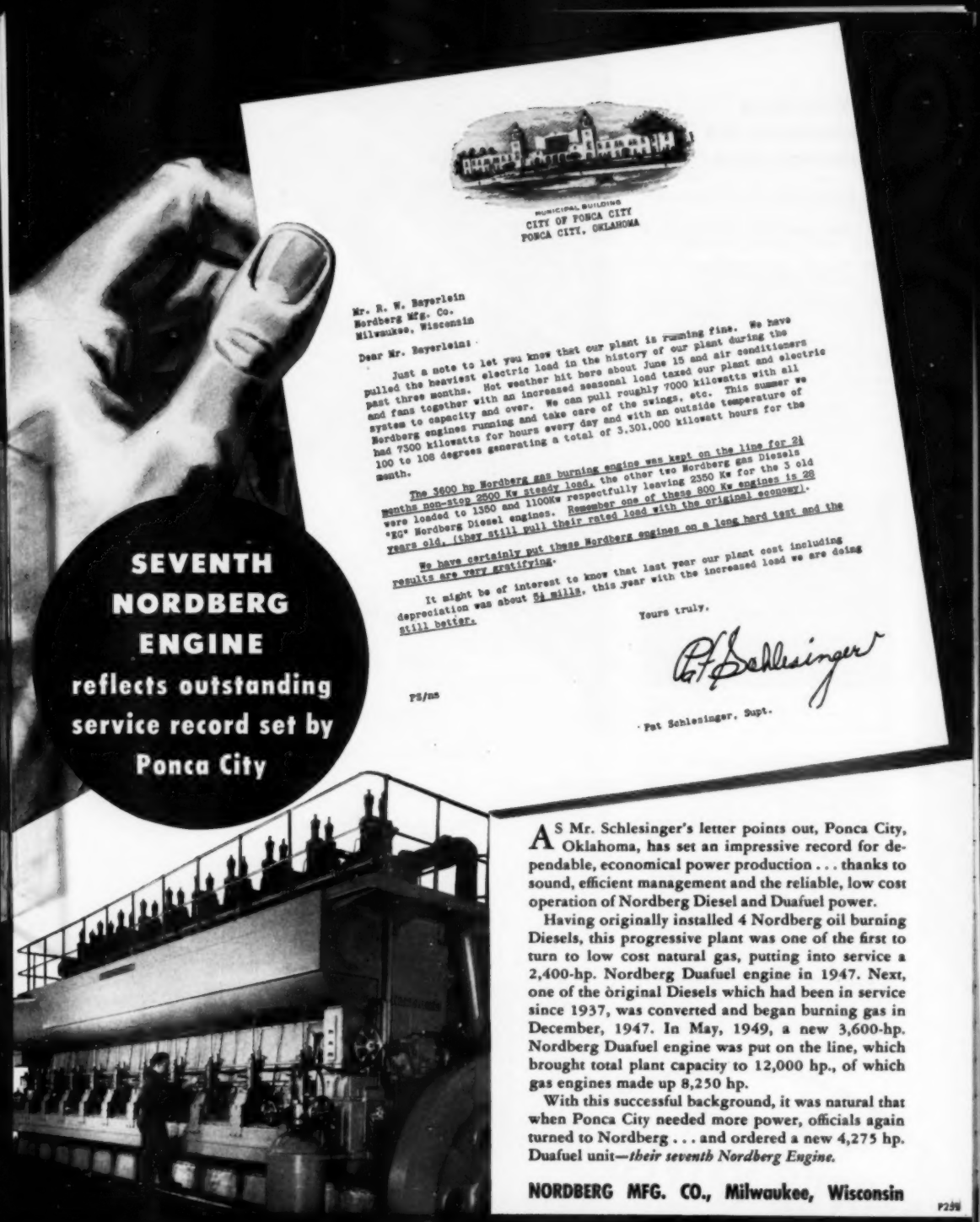
Longer Lasting
ALOYCO VALVES
1st in Corrosive Service

Lasts longer in corrosive service

ALOYCO sampling valves are functionally designed for convenience and dependability.

Like all ALOYCO valves, these specialized valves are the result of extensive metallurgical research and engineering and the production of high alloy valves exclusively.

ALOYCO No. 733 Sampling Valve has an ingenious expansion chamber which enables samples to be taken without splattering.


MUNICIPAL BUILDING
CITY OF PONCA CITY
PONCA CITY, OKLAHOMA
Mr. R. W. Bayerlein
Nordberg Mfg. Co.
Milwaukee, Wisconsin
Dear Mr. Bayerlein:
Just a note to let you know that our plant is running fine. We have pulled the heaviest electric load in the history of our plant during the past three months. Hot weather hit here about June 15 and air conditioners and fans together with an increased seasonal load taxed our plant and electric system to capacity and over. We can pull roughly 7000 kilowatts with all Nordberg engines running and take care of the swings, etc. This summer we had 7300 kilowatts for hours every day and with an outside temperature of 100 to 108 degrees generating a total of 3,301,000 kilowatt hours for the month.
The 3600 hp Nordberg gas burning engine was kept on the line for 24 months non-stop 2500 Kw steady load, the other two Nordberg gas Diesels were loaded to 1360 and 1100Kw respectfully leaving 2350 Kw for the 3 old "GG" Nordberg Diesel engines. Remember one of these 800 Kw engines is 20 years old, (they still pull their rated load with the original economy).
We have certainly put these Nordberg engines on a long hard test and the results are very gratifying.
It might be of interest to know that last year our plant cost including depreciation was about 5¢ mills, this year with the increased load we are doing still better.
Yours truly,
Pat Schlesinger
PS/ms
Pat Schlesinger, Supt.
SEVENTH NORDBERG ENGINE
reflects outstanding service record set by Ponca City

AS Mr. Schlesinger's letter points out, Ponca City, Oklahoma, has set an impressive record for dependable, economical power production . . . thanks to sound, efficient management and the reliable, low cost operation of Nordberg Diesel and Duafuel power.

Having originally installed 4 Nordberg oil burning Diesels, this progressive plant was one of the first to turn to low cost natural gas, putting into service a 2,400-hp. Nordberg Duafuel engine in 1947. Next, one of the original Diesels which had been in service since 1937, was converted and began burning gas in December, 1947. In May, 1949, a new 3,600-hp. Nordberg Duafuel engine was put on the line, which brought total plant capacity to 12,000 hp., of which gas engines made up 8,250 hp.

With this successful background, it was natural that when Ponca City needed more power, officials again turned to Nordberg . . . and ordered a new 4,275 hp. Duafuel unit—*their seventh Nordberg Engine.*

NORDBERG MFG. CO., Milwaukee, Wisconsin

P259

BUSCH-SULZER
A DIVISION OF NORDBERG

NORDBERG
DIESEL ENGINES

TROUBLE FREE FOR 15 YEARS handling muriatic acid!

Another 'open and closed' case for

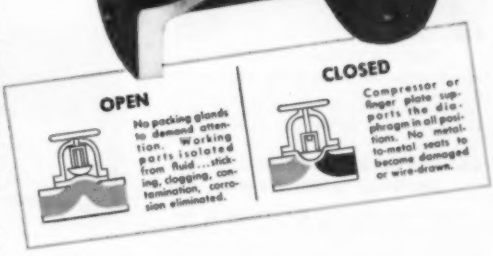
GRINNELL-SAUNDERS DIAPHRAGM VALVES

In 1936, a Canadian mine installed Saunders Diaphragm Valves with rubber linings on the feed and drain piping of an underground tank used for the storage of muriatic acid. Today, after 15 years, those *same* valves are in use—having required no maintenance except for periodic replacement of diaphragms, a simple operation done without removing the valve from the line.

Grinnell-Saunders Diaphragm Valves are available in many different combinations. Bodies are made in a variety of metals —iron, stainless steel, bronze, aluminum and others. ***But of more importance*** is the fact that a body of cast iron (a metal not in short supply) can be lined with glass, lead, natural rubber, neoprene and other materials which, in many instances, handle corrosive fluids *better* than metals.

Diaphragms come in natural rubber, neoprene, butyl, hycar, a special synthetic for foods and KEL-F. This last is chemically inert to all acids and alkalies in all concentrations with the exception of molten alkali metals.

From this broad selection of materials, the problems which the Grinnell-Saunders valve can solve are extremely varied. No wonder industry after industry is putting it on the line.


OPEN
No packing glands to demand attention. Working parts isolated from fluid ... sticking, clogging, contamination, corrosion eliminated.
CLOSED
Compressor or finger plate supports the diaphragm in all positions. No metal-to-metal seats to become damaged or wire-drawn.

GRINNELL
WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

New equipment and developments

(Continued from page 24)

cient air for combustion is flowing through the burner. For 115 v, 60 c operation, styles are available for pressure

ranges of 150 psi with 15 gph flow and 125 psi with 40 gph flow and a 6½ sec time delay.

43—Connector provides fast wire splicing

For making pigtail splices in electrical wiring, Minnesota Mining and Manufacturing Co. has developed a spring-type connector said to provide a tight permanent splice for single or multi-strand wires up to gage 10. Made in the form of a tapered coil spring, the Scotchlok connector is screwed on with

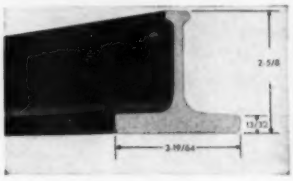
the fingers—leverage being applied to a notched turning stem. To complete the splice, the stem is snapped off and insulating tape is applied.

44—Ion exchange resin features reduced costs

Many advantages are claimed for Amberlite IR-112, a low cost medium capacity ion exchange resin developed by Rohm & Haas. Available for general use, it is said to have high regeneration efficiency, low leakage characteristics, resistance to oxidizing and reducing media as well as solvents, and stability up to 250 F over the entire pH range. Additional information is presented in available literature.

45—Lighter tramrail section affords economy

Forker Corp., manufacturer of Ohio Tramrail Systems, has introduced a lighter Teerail section. Designated B-2800, it weighs 6.9 lb per ft as compared to 9.6 lb for the former section. Weight economy is obtained by reducing web height. Tread width is the



same as that of the original section and also that of the heavier Beamrail sections, so that the new section may be tied in with existing systems.

46—Paint can be applied over rust

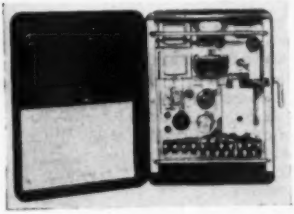
Chromate anti-rust paints introduced by Chem Industrial Co., can be applied directly over rusted surfaces without wire brushing or sandblasting. One coat of Overust is said to be sufficient to prime, penetrate and seal all metal surfaces. For brushing or spraying on any metal, interior or exterior, it is resistant to moisture, temperature changes, chemicals, acids and fumes.

TO REQUEST ADDITIONAL FREE DATA

Insert " key" numbers on return post card found on page 131. Our Reader's Service Department will handle your request promptly

47—Control automatically programs burner operation

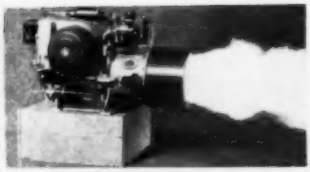
Automatic starting of oil, gas and combination burner equipment and programming of pre-purge, ignition-on, fuel valve delay, post-ignition timing



and post-purge operations is possible with Fireye programming control, type 26RJ8, manufactured by Combustion Control Corp. In addition, component failure within equipment causes instantaneous shut-down and prevents start-up under unsafe conditions. Additional information is provided in a bulletin.

48—Burners feature many improvements

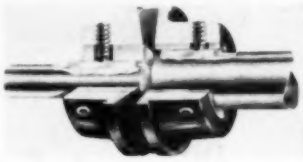
Two oil burners, models AM5-H and AM6-H, with capacities of 25 and 40 gph respectively, have been announced



by Cleaver-Brooks Co. Many advantages are claimed for the units, which are lighter and more compact than former models.

49—Couplings offer many bore combinations

Bushed type flexible couplings developed by Maurey Manufacturing Co. offer many possible bore combinations. For applications to 10 hp, the units consist of two cast iron hubs joined by



a bonded rubber section perfected by Goodyear Tire and Rubber Co. Descriptive data is available.

50—Tachometers provide wide range

Hand tachometers featuring improved design have been announced by O. Zernickow Co. A knife-edge hand makes almost two complete revolutions for each range. This results in a long scale with wide open divisions. Universal models are available in ranges of 25 to 30,000 and 30 to 40,000 rpm. Single range units provide a 300 to 4000 rpm range. Additional design improvements are discussed in available data sheet.

51—Contact wheel has replaceable tire

Chicago Rubber Co. has developed a contact wheel, for use with abrasive belt grinding units, which requires only the replacement of the rubber tire. The Universal type T-54 consists of a split

aluminum hub which is joined by four Allen screws to lock the tire in place. Standard face widths of 1 to 6 in. are available in either plain surfaces or a variety of slot designs.

—End

"Major utilities now grant complete acceptance to inhibited turbine oils"

. . . and here's why so many of them choose **SHELL TURBO OIL**

Shell Turbo Oil exceeds every accepted specification for premium turbine lubricants. These are the notable qualities:

1. HIGHEST ATTAINABLE RUST PROTECTION

An effective *combination* of rust inhibiting additives goes to work at the source of rust formation. Rust problems are reduced to the very lowest level.

2. COMPLETE OXIDATION STABILITY

The anti-oxidant in Shell Turbo Oil has so far defied improvement! It provides outstanding oxidation stability and thereby minimizes sludge formation.

3. ANTI-FOAMING

The anti-foam agent now used is so effective that air entrainment can be tolerated for considerable periods . . . avoiding unscheduled shutdowns.

4. EXCELLENT EMULSION CHARACTERISTICS

Shell Turbo Oil's remarkable protection against rust and oxidation is attained with the minimum tendency to formation of water emulsions in service.

5. PROTECTION AGAINST WEAR

The inhibitive agents in Shell Turbo Oil *add* to the wear-reducing qualities of the specially refined oil itself, an extra margin of safety for the bearings during critical starting period.

For additional information on Shell Turbo Oil mail coupon.

SHELL TURBO OIL

SHELL

SHELL OIL COMPANY
50 West 50th Street, New York 20, N. Y.
or 100 Bush Street, San Francisco 6, Cal.

Please send information on Shell Turbo Oil.

Name_____

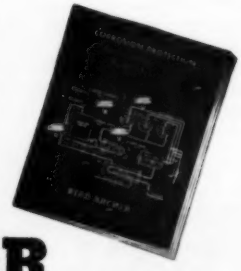
Company_____

Address_____

Corrosion of piping in steam and condensate return lines is an expensive two-way headache. (1) It leads to large outlays for pipe replacement and maintenance. (2) It often results in plugged return lines and traps due to the solid products of corrosion. Bird-Archer Amine Treatment effectively eliminates these troubles at low cost.

Here's how. Amines are fed into the boiler or into the steam and condensate systems. The amines raise the pH value of the condensate and also tend to inhibit equipment-destroying corrosion through surface protection of the metal itself. In scores of plants, this Bird-Archer system has more than paid for itself by substantially cutting replacement and maintenance costs.

Bulletin CP 100
gives all the facts on Bird-Archer Amine Treatment. Write for your copy.

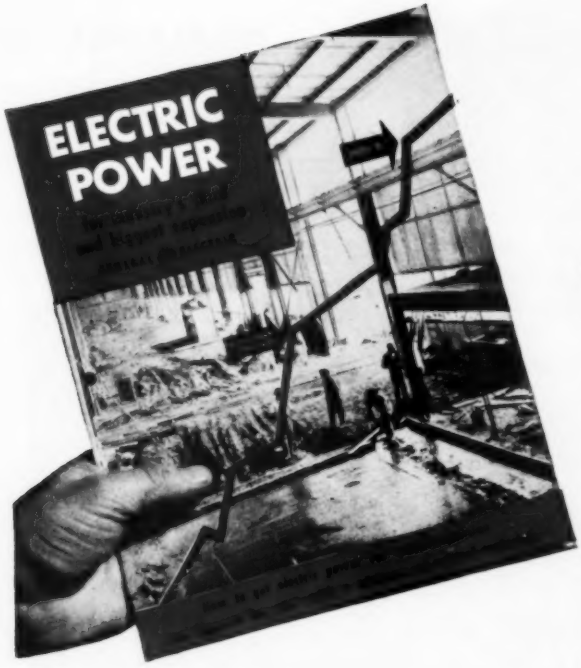


BIRD-ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 4337 NORTH AMERICAN ST., PHILADELPHIA 40, PA.
NEW YORK • CHICAGO

IN CANADA: The Bird-Archer Co., Limited, Cobourg, Ontario
In Mexico: Calderas y Accesorios, S.A., Amsterdam 291, Mexico, D.F

BA 166



Here's your guide to quick economical power expansion

Here is a helpful booklet that tells you how to plan your plant electrical system to meet today's need for more production—at low cost!

If you're planning for plant expansion—if you want more electric power to keep machines operating at top capacity—if you recognize the need for a more modern, more dependable electric power system—here's a booklet that may mean thousands of dollars to you in over-all equipment savings and lowered production costs.

It tells how hundreds of plants today are expanding and modernizing their electrical systems with the latest developments in G-E standardized "packaged" power distribution equipment.

It shows how you can cut corners in getting the equipment you need in the quickest time and with the least trouble. It demonstrates how you can often save through reduction of power losses—how you can plan effectively to meet future needs for years ahead.

This booklet is profusely illustrated with photographs of actual installations—some of them probably applicable to your plant. Send now for your copy—General Electric Company, Schenectady 5, N. Y.

Tells how to:

- Get more power for expanding production.
- Modernize old electric systems easily and economically.
- Save months in getting urgently needed electrical equipment.
- Cut equipment and installation costs.
- Conserve vital materials and manpower.
- Simplify planning, purchasing and engineering problems.
- Plan economically to provide for future growth.
- Guard against power shut-downs and lost production.
- Provide greater protection for your plant and more safety for personnel.

Section 321-86
General Electric Company
Schenectady 5, New York

Please send me a copy of bulletin GEA-5600, "Electric Power—for America's Third and Biggest Expansion."

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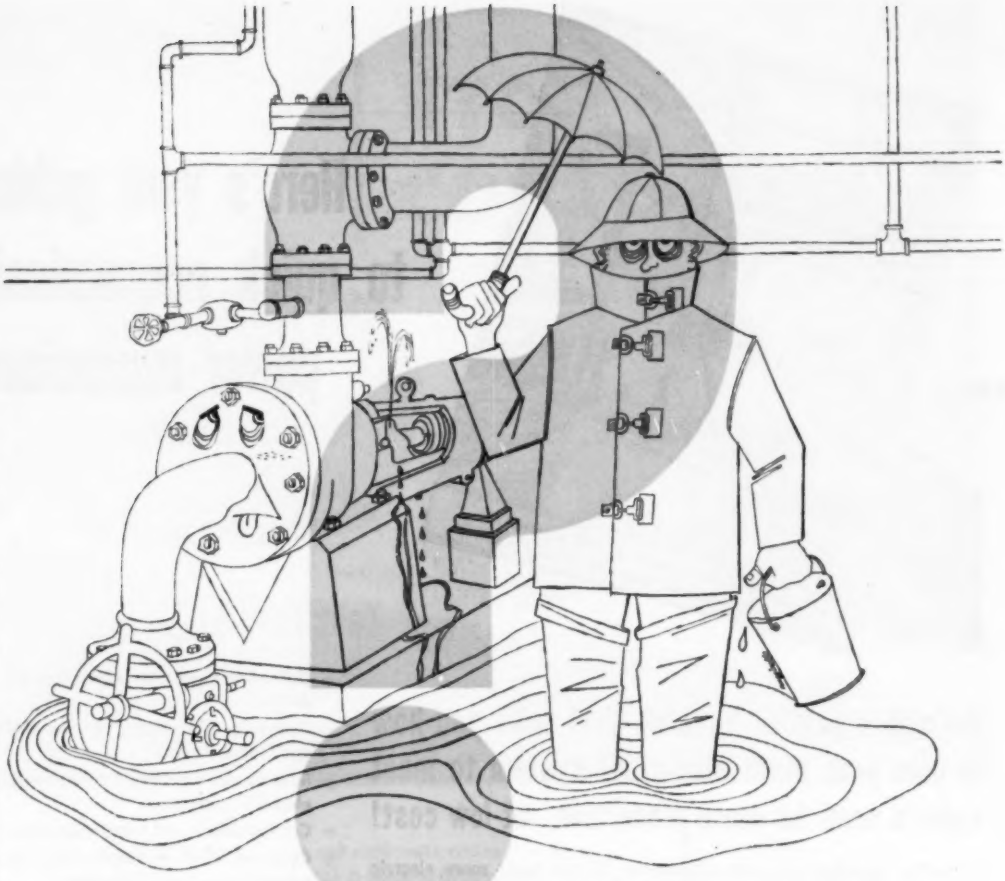
GENERAL ELECTRIC



*Who needs a mechanical seal?**

If you've got hip boots, a bucket and a standby maintenance crew with nothing to do, why bother with a BJ Mechanical Seal? Take a devil-may-care, every-pump-for-itself attitude and let the packing fall where it may. Or if your maintenance department enjoys a "Quick-save-the-dikes" sort of life, they will have great fun poking in packing before the stuff completely goes.

BUT . . . if your business allows little room for exciting crises and repacking picnics, you should know about the BJ Mechanical Seal. This excellent, precision-made seal – available in a number of engineered types – takes the trouble right out of any stuffingbox. There's no leakage . . . no waste . . . no contamination of pumped liquid . . . no volatile liquid hazard . . . no profit-robbing repacking and delivery-delaying downtime.

Maybe *you* need a BJ Mechanical Seal for your BJ Pump. Ask your local Byron Jackson office for details or write:

Byron Jackson Co.

Since 1872

P. O. Box 2017, Terminal Annex, Los Angeles 54, California

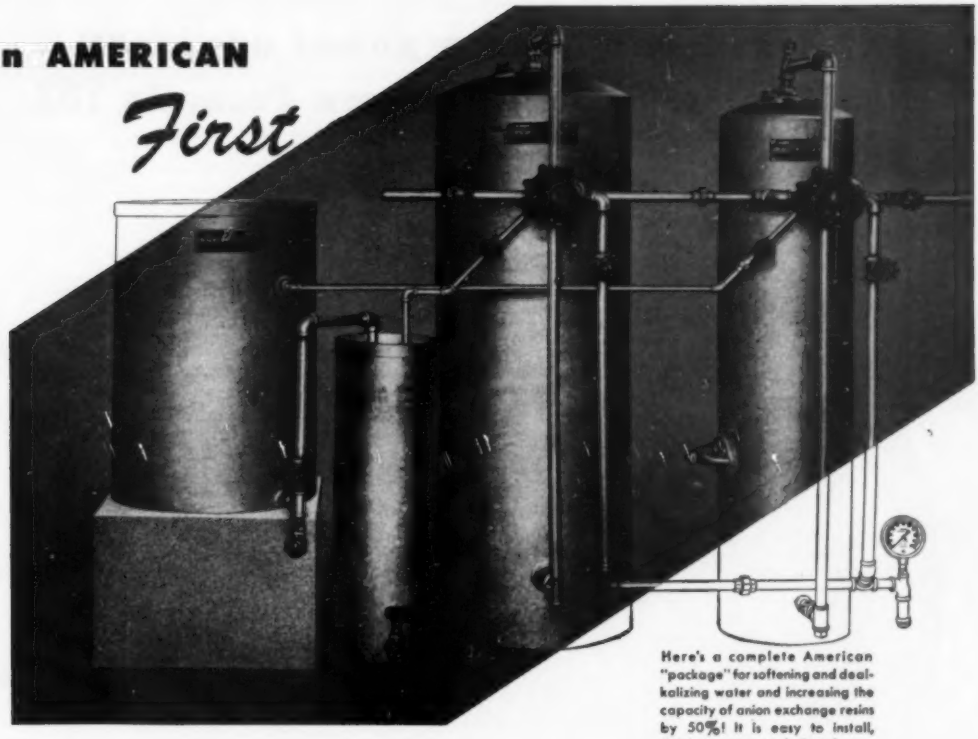
OFFICES IN PRINCIPAL CITIES

**BJ Mechanical Seals are made exclusively for BJ Pumps.*

SEE **BJ** FOR THE ENGINEERED ANSWER TO YOUR PUMPING PROBLEMS

an AMERICAN

First



Here's a complete American "package" for softening and dealkalizing water and increasing the capacity of anion exchange resins by 50%! It is easy to install, simple to operate, built to last.

new, safe Dealkalization Process*

that saves you up to 33%

With this new process equipment developed by American, capacity of anion exchange resins is easily increased from 33 to 50%.

These resins function to adsorb objectionable sulfates, carbonates and other anions from water. With only common salt used as the regenerant, however, it was found that exchange capacity of the resin was extremely low, due to the formation of blanketing gases which prevented complete regeneration of the resin bed.

American engineers found the answer. By raising the pH of the regenerant solution the tendency toward gas blanketing of the resin is eliminated.

This process increases the capacity of the exchange bed and greatly improves the quality of the effluent.

American engineers are specialists in all types of water treatment with a background of successes for over half a century. Regardless of your problem, their experience will enable them to find a solution. Why not get in touch with them. Write today for details of this new process.

**Patent applied for.*

CELEBRATING OUR AMERICAN SYSTEM W A S C PATENTED FIFTIETH YEAR

AMERICAN *Water Softener* COMPANY

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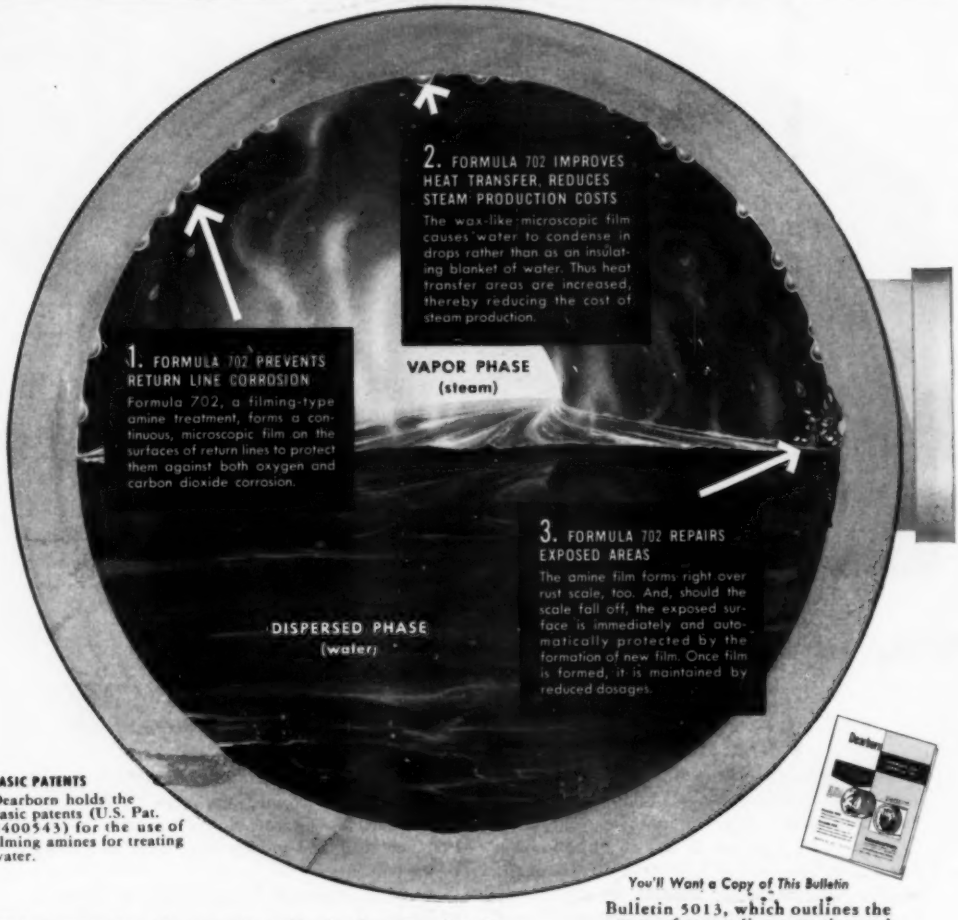
FILTERS • SOFTENING SYSTEMS • CHEMICAL FEEDERS • ION EXCHANGERS • RE-ACTORS • SWIMMING POOL EQUIPMENT • DE-GASIFIERS • WATER TEST SETS • RE-CARBONATORS • ALKALIZERS

3 reasons why every power engineer should know about Dearborn Formula 702


2. FORMULA 702 IMPROVES HEAT TRANSFER, REDUCES STEAM PRODUCTION COSTS
The wax-like microscopic film causes water to condense in drops rather than as an insulating blanket of water. Thus heat transfer areas are increased, thereby reducing the cost of steam production.
1. FORMULA 702 PREVENTS RETURN LINE CORROSION
Formula 702, a filming-type amine treatment, forms a continuous, microscopic film on the surfaces of return lines to protect them against both oxygen and carbon dioxide corrosion.
VAPOR PHASE (steam)
3. FORMULA 702 REPAIRS EXPOSED AREAS
The amine film forms right over rust scale, too. And, should the scale fall off, the exposed surface is immediately and automatically protected by the formation of new film. Once film is formed, it is maintained by reduced dosages.
DISPERSED PHASE (water)

BASIC PATENTS
Dearborn holds the basic patents (U.S. Pat. 2400543) for the use of filming amines for treating water.

This cross-section of a return line, showing how *Dearborn Formula 702,* which is fed directly into the boiler, works to eliminate costly corrosion, reduce maintenance, avoid shutdowns and protect valuable equipment. If the pH value of your steam condensate is excessively low, it will pay you to discuss Formula 702 with your Dearborn Engineer.

DEARBORN CHEMICAL COMPANY • Merchandise Mart Plaza • Chicago 54, Illinois

You'll Want a Copy of This Bulletin

Bulletin 5013, which outlines the causes of return line corrosion and the method of cure with Formula 702, will be sent on request.

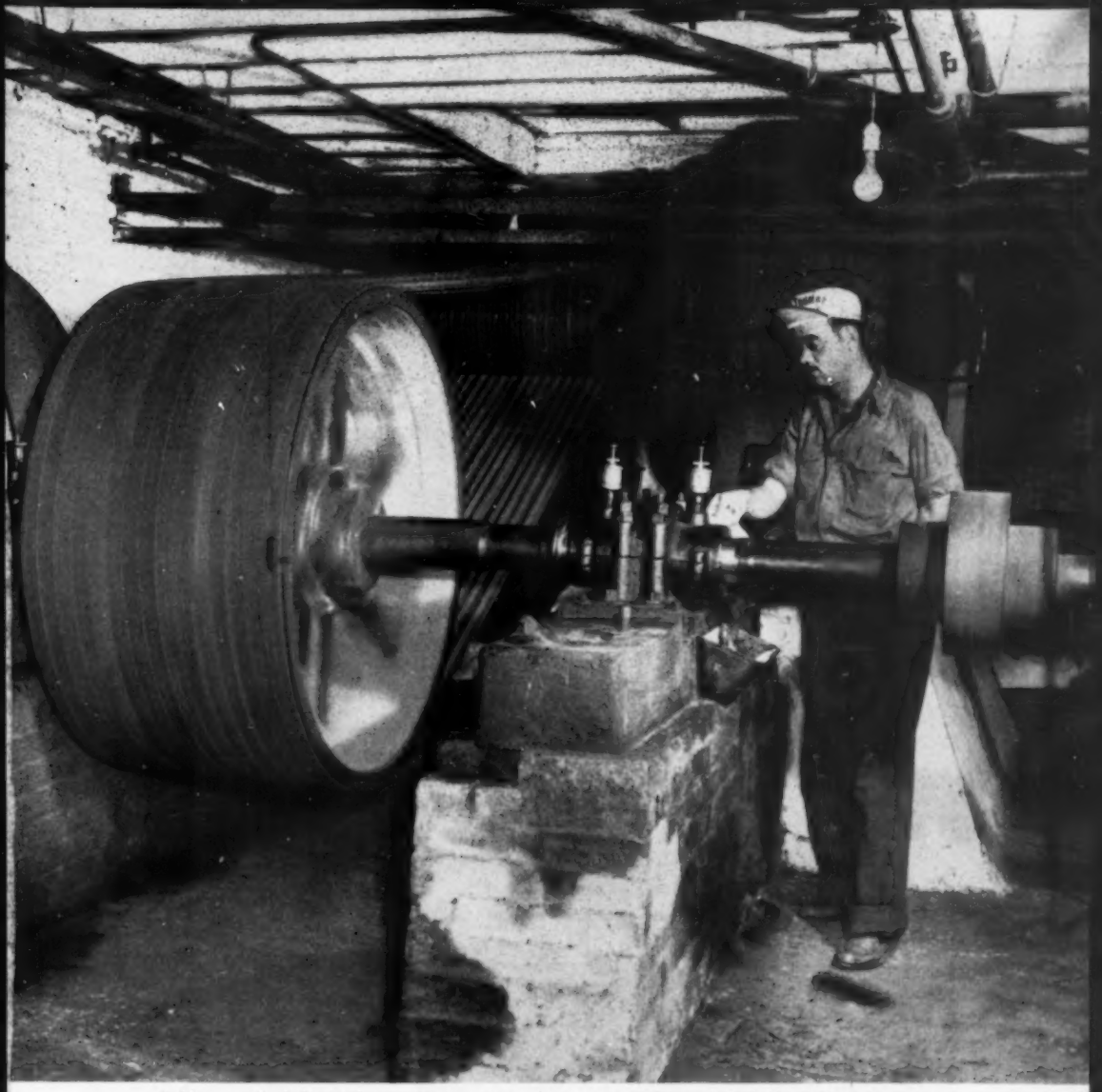
Dearborn Chemical Company Dept. INP
Merchandise Mart Plaza
Chicago 54, Ill.

( ) Send a copy of Bulletin 5013
( ) Have a Dearborn Engineer call

Name.....
Position.....
Company.....
Address.....
City.....*Zone*.....*State*.....

Dearborn
TRADE MARK REGISTERED
THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

B.F.Goodrich GROMMET BELTS AT WORK



Rubber muscles help put the squeeze on cottonseed—to make oil for tastier salads, flakier pie crusts.

Puts squeeze on cottonseed

The V belts in the picture carry power to squeeze cottonseeds into oil for salads and shortening. The heavy load and high speeds caused the V belts previously used to wear out rapidly—sometimes they failed after just a few months. Obviously, *a new kind of belt was needed.* See the following pages to learn how this problem was solved.

Puts squeeze on seeds (continued)

B. F. Goodrich grommet V belts on job 7 years when picture was taken—best record for previous belts: only 7 months!

The problem on the preceding page was solved by a distributor's suggestion that B. F. Goodrich grommet V belts be tried in place of the short-lived belts. The grommet belts shown above are one of the first sets ever installed—have been at work *7 years*, have already saved $1,750 in replacement belt costs and are expected to run for many more years!

20 to 50% Longer Life

Patented grommet V belts by B. F. Goodrich represent the only basic improvement since invention of the V belt. Belts last 20 to 50% longer, depending on service. (The more severe

the service the greater the increase over ordinary belts.)

What is a Grommet?

A grommet is like a giant cable except that it's endless—a cord loop built up by winding heavy cord on itself. There is no overlapping cord *section* as in all ordinary belts. Most belt failures occur in these sections where cords overlap!

All Cords Put to Work

Each grommet and every part of a grommet carries its share of the load. In ordinary belts under high tension the center cords "dish" because tension is greater near the driving faces. Dished cords are doing less work, not pulling their share. Grommet V belts have no center cords, there is no dishing—therefore much more strength in proportion to cord volume.

Better Grip, Less Slip

Grommet V belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give ⅓ more gripping power, pull heavier loads with a higher safety factor.

They Cost No More

You save belt costs because belts last longer, reduce production costs because machines keep running with fewer interruptions, reduce maintenance costs because they need less attention, yet cost not one cent more than others. Grommet belts are made in C, D and E sections. They are patented by B. F. Goodrich. No other V belt is a grommet belt (U. S. Patent Number 2,233,294).

See "X-ray" Belt

A special demonstrator "X-ray" belt has been made to show the grommet construction. Ask your local B. F. Goodrich distributor to show it to you.

Saved $250 a year!

These belts have to run 24 hours a day under terrific tension. Ordinary V belts used to snap in two, fly off this drive in only 4 months. In September 1950, BFG grommet belts were installed. They have already lasted 4 times as long as previous belts, still look good and are saving over $250 a year in replacement costs!

BFG grommet V belts can be counted on to save on belt costs.

B.F.Goodrich GROMMET BELTS AT WORK

24th oil well

These B. F. Goodrich grommet V belts are running a mud pump on an Oklahoma oil drilling rig. When the picture was taken, they'd been in continuous service for 14 months. And this job was their 23rd well, representing a total of 15 miles of drilling. In spite of the continuous high speed operation and exposure to all kinds of weather, these B. F. Goodrich belts showed very little wear; were moved to their 24th well!

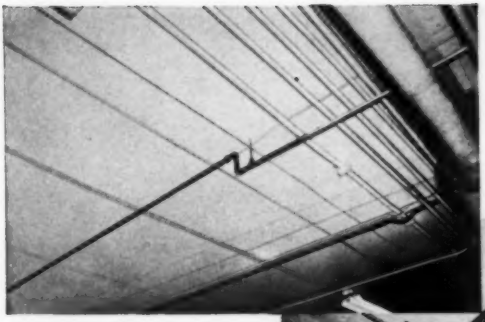
The grommet V belt is a typical B. F. Goodrich improvement—an improvement that saves money, does jobs better for industries of all kinds. Good reasons why it will pay you to get in touch with your B. F. Goodrich distributor when you need V belts.

← *Rubber harness keeps a mud pump at work.*

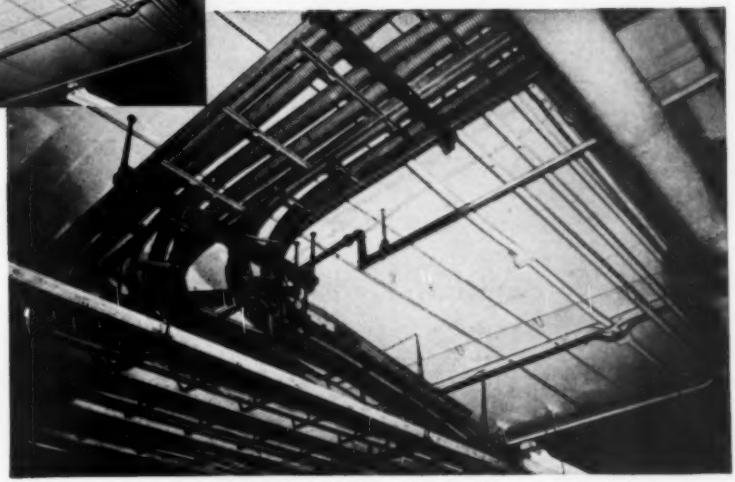
These typical examples (see preceding pages) tell you why B. F. Goodrich grommet belts are superior to ordinary V belts — prove they last 20 to 50% longer—yet cost no more.

Grommet V Belts BY
B.F.Goodrich
FIRST IN RUBBER

The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio



GETTING DISTRIBUTION IN FAST was the big problem in the conversion of a Midwest warehouse to a defense plant. Here the ceiling was available for wiring, but a decision had to be made on the type of wiring that would go in fast and offer the most practical results.

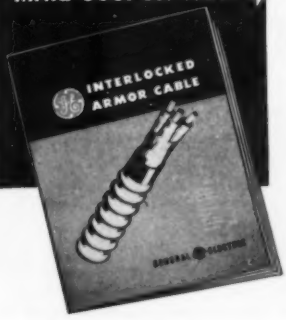


IN RECORD TIME this neat, efficient installation of G-E interlocked armor cable went into place. No detailed layout was necessary . . . cable was simply laid up on racks without need for extra protection.

Get the Facts on Installation Speed from this NEW G-E Interlocked Armor Cable Catalog

This new 20-page catalog tells you the important time-saving, cost-saving advantages of the G-E interlocked armor cable system. It offers new ideas in installation speed, explains the important benefits you get when you put up raceway and cable at the same time. Send for your copy today.

MAIL COUPON NOW



Section W23-744, Construction Materials Division,
General Electric Company, Bridgeport 2, Connecticut

Please send me your new, free catalog, "G-E Interlocked Armor Cable," Pub. No. 19-211.

Name_____ Title_____

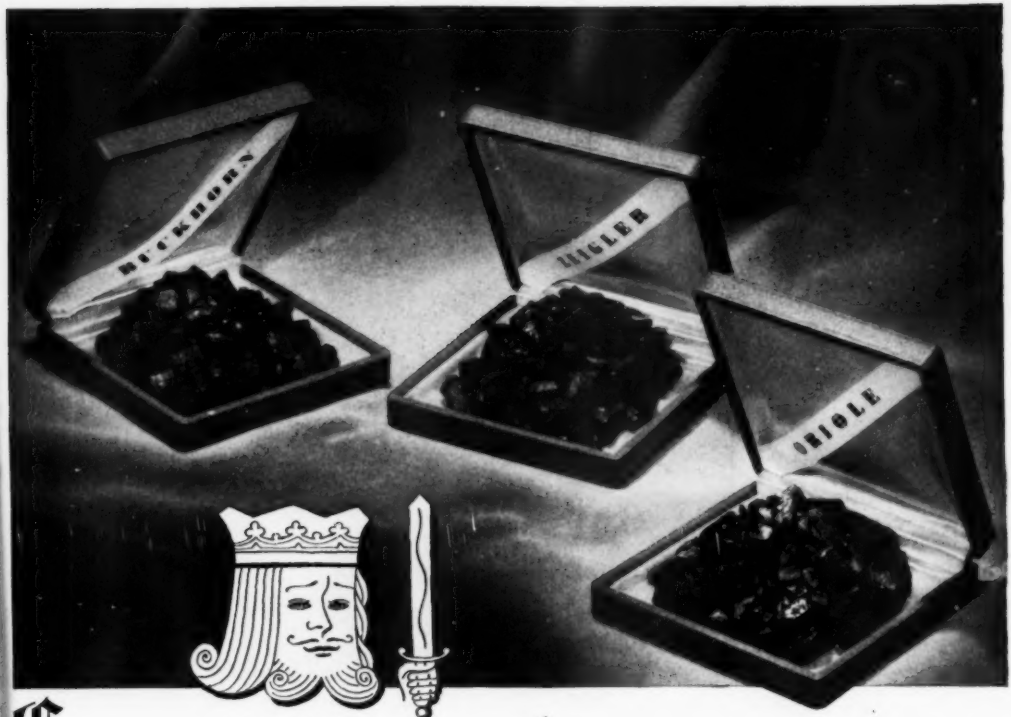
Company_____

Address_____

City_____ Zone____ State_____

You can put your confidence in—

GENERAL ELECTRIC



Command performance! for BELL & ZOLLER COALS

Yes, every order for Bell & Zoller Coals is a *command performance.* Whether your specific requirements demand the characteristics of Buckhorn, Zeigler or Oriole, you are certain of receiving top-quality, incomparable performance.

Zeigler and heat-dried Buckhorn from Southern Illinois, and Oriole from Western Kentucky, are all superwashed, scientifically-cleaned coals . . . correctly sized and processed to meet rigid specifications. These free-burning, low ash, low moisture coals are top performers in keeping steam costs at a minimum.

Let us help you determine exactly what your coal needs are—in quantity, quality and cost. A Bell & Zoller combustion engineer will gladly arrange a consultation at no obligation. Telephone, write or wire our nearest office today.

COAL HEATING SERVICE

BELL & ZOLLER COAL COMPANY

BELL BUILDING, CHICAGO 1, ILLINOIS

ST. LOUIS • NASHVILLE • OMAHA • MINNEAPOLIS

Sixty-Six Years of Service to Coal Users

Producers of
ZEIGLER, MOSS HILL, ORIOLE, MURDOCK, and BUCKHORN Coals

Sales Agents for
Otter-Creek Coal Company
Lockwood, West Virginia

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Terre Haute, Indiana

Boone County Coal Corporation
Sharples, West Virginia

CONTROL YOUR FEED

BUILD UP YOUR PROFITS . . . THIN OUT YOUR LOSSES

With Jeffrey-Traylor Feeders on the job the flow of coal (or other material) is under absolute control at all times. Photo shows two No. 5 J-T Feeders under track hoppers and feeding to Jeffrey Spiral Conveyor which takes coal to the various bunkers ready for use.

You virtually put your power plant on a strict diet . . . the feeders regulating the amount to be fed, exactly . . . just set 'em and forget 'em. J-T electric-vibrating Feeders are practically foolproof . . . nothing to wear out or lubricate. Power consumption is unusually low.

We build a type and size Feeder (desired capacity) to take care of your feeding requirements properly — tubular or pan decks, single or multiple power units. We also apply electric vibration to Conveyors, Screens, Dryers, Coolers and Packers. To be sure — better buy Jeffrey.

PARTIAL LIST OF WHAT WE MAKE

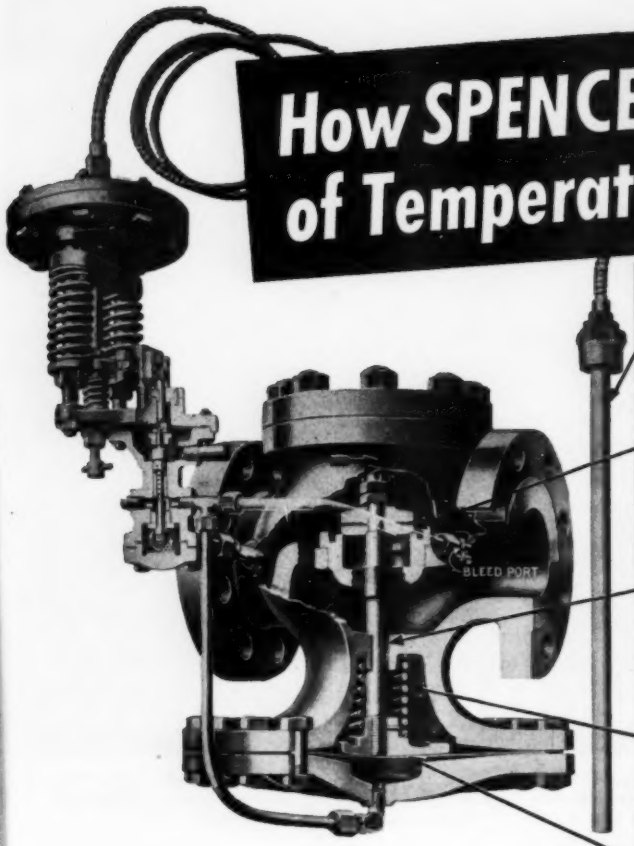
BIN VALVES . BUCKET ELEVATORS . CHAINS . COOLERS . CONVEYORS . CRUSHERS . DRYERS . IDLERS (BELT) . FEEDERS
PULVERIZERS . WEIGH FEEDERS . PACKERS . SCREENS . CAR PULLERS . SPROCKETS . TRANSMISSION MACHINERY

Literature On Request

JEFFREY

1877 75 1952

How SPENCE Cuts Costs of Temperature Control



NEW THERMOSTAT ELEMENT—Improved to practically eliminate loss of filling. Rugged construction; cannot be injured by overheating.

SECO METAL—Seats and discs are made of SECO Metal—guaranteed not to wire-draw.

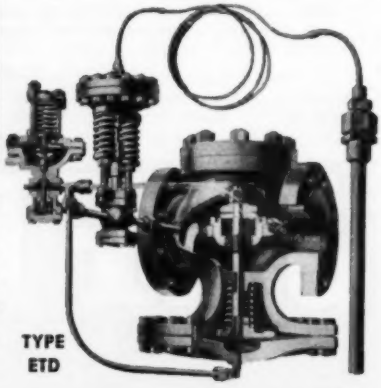
PACKLESS CONSTRUCTION — All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . eliminates much time-consuming maintenance.

PROTECTED SPRINGS — Springs in the Spence Regulator are out of the path of the steam or other fluid flowing through the valve.

LARGE BALANCED DIAPHRAGM— Spence metal diaphragms, under usual conditions, never require replacement.

Accurate Control for Both Storage and Instantaneous Heaters

Spence Temperature Regulators reduce the steam pressure and also accurately modulate the flow as required to control the temperature. No separate reducing valve is necessary • The Spence ET150 Regulator is recommended for heater pressures up to 50 psi. For higher pressures the Type ETD is available • For complete details on the entire Spence line of automatic regulating valves, strainers and desuperheaters, write for Bulletin 1200.



TYPE ETD

SR 111

Spence

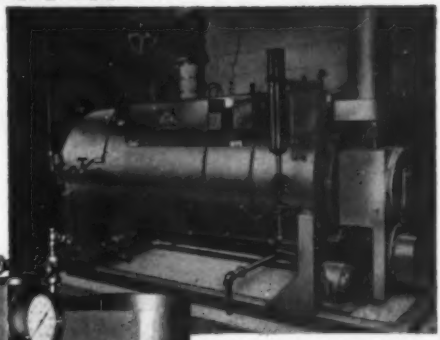
SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

You can Save on Steam

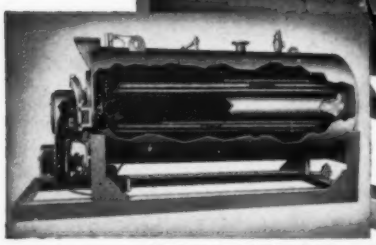
with highly efficient

Continental

PACKAGED AUTOMATIC BOILERS



This 35 HP light oil Continental unit heats a new chapel at Valley Forge Military Academy, Wayne, Pa.



Cut-away view showing 2-pass construction and simple refractory at back of boiler.

Save on installation, fuel and maintenance

Here is an economical, highly efficient source of steam for heat or processing. The Continental Automatic Boiler guarantees you at least 80% efficiency, with steam moisture content under 1%—by actual independent tests. Simplified design of the unit, based on 40 years' boiler engineering experience, assures dependable, low-maintenance service year after year.

Because no refractory is used at burner or for baffles, the Continental can be opened front and back in 15-20 minutes, permitting easy access for cleaning and maintenance and eliminating troublesome replacement of refractory. Water fully surrounds the boiler furnace, where all fuel is burned, and the gases pass spirally through the tubes, resulting in maximum heat transfer, low flue gas temperature, and high efficiency.

The Continental Automatic Boiler is equipped with dependable controls of finest quality for fully automatic operation. The burner, specially designed for the boiler, is available for heavy oil, light oil, gas, or a combination. Ready for operation after simple service connections. Generator sizes range from 10 to 500 HP, for high and low pressure.

Before deciding on equipment to meet your specific needs, be sure to compare the Continental cost-saving features. We'll gladly send you details. Clip and mail the coupon today.

BE

DISTRIBUTORS—PLEASE NOTE:

A few choice territories are open. Request details today on your company letterhead.

BOILER ENGR. AND SUP. CO., INC.
Manayen Street
Phoenixville, Pa.

I'm interested in the savings offered by Continental Automatic Boilers—please send me latest literature.

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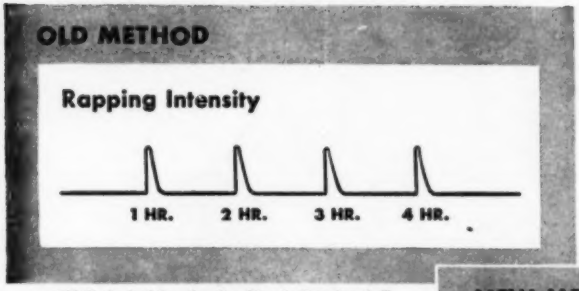
New Development

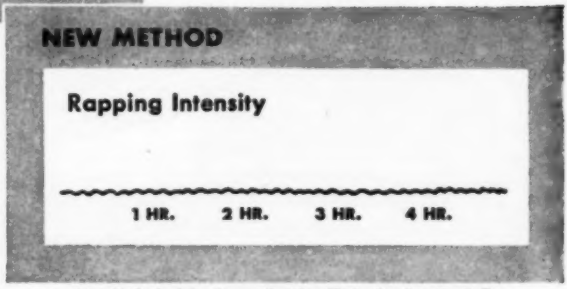
FOR ELECTRICAL PRECIPITATORS

ELIMINATES RAPPING PUFFS



Old Method of Rapping Resulting in Rapping Puff

Here are two simple diagrams that clearly demonstrate the importance of the new method of rapping developed by Research Corporation. The first shows the old way in which dust is shaken loose from electrodes at *periodic* intervals, causing intermittent puffs or clouding.



New Method of Continuous Rapping Eliminating Rapping Puffs
Rapping Intensity

This second diagram illustrates the new scientific method of cleaning electrodes. It involves continuous or sequential rapping, every minute or less, at a controlled vibrational intensity. This converts precipitation from a batch operation to a *continuous and uniform process.*

This is another major contribution by Research Corporation to the field of electrical precipitation. Constant research and development work for the past 39 years has resulted in many other improvements over the first Cottrell Precipitator. These advances plus the unequaled experience gained through over 1000 installations, listed at right, assure you of a profitable solution to your specific problem.

RESEARCH CORPORATION INSTALLATIONS

55 Carbon Black Plants
208 Metallurgical Installations
215 Acid Plants • 34 Paper Mills
293 Detarring Installations
251 Power Stations
86 Steel Plants • 114 Oil Refineries
and Miscellaneous Installations

Want to know more about the new Rapping System? Bulletin FA contains additional data. Send for your copy.

RESEARCH CORPORATION

405 Lexington Avenue, New York 17, N. Y.
122 South Michigan Avenue, Chicago 3, Illinois
Bound Brook, New Jersey

RC-189

Gates V-Belts are chosen to keep HELICOPTERS aloft!

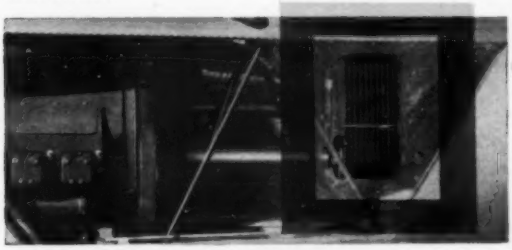
McCulloch Tandem-Rotor Helicopter

(Above) Two-place helicopter employs tandem-mounted, intermeshing rotors—a total of six rotor blades—powered by a 200-hp, six-cyl., aircooled horizontal engine installed at the rear. (Lower left) Gates-engineered V-BELTS, shown to rear of the engine, transmit power from the engine to the main drive shaft which in turn drives the reduction gearing for the rotors.

Because a helicopter is air-borne entirely by the turning of its rotors, McCulloch Engineers who designed this helicopter and supply it to the Navy had to be sure that the drive to the rotors was, above all, safe and reliable—a drive that would not fail when the helicopter was in the air.

The special difficulty in designing this drive was the extreme *compactness* required.

On small diameter pulleys and short center distances, the drive must handle 200 horsepower for 1000 hours at cruising speed and 500 hours at high speed. Ordinarily, it would have been impossible to achieve these results.



A Notable Application of Gates SPECIALIZED Research

However, Gates had developed a V-Belt which in thousands of applications had proved to have the exact characteristics required for this helicopter drive—and Gates had also developed design data which showed at once the applicability of this belt.

It was not by accident, therefore, that Gates Engineers were at once prepared to supply a V-Belt capable of handling this most exacting assignment and —in close co-operation with McCulloch Engineers—they developed the drive shown which has most successfully met all requirements.

Gates readiness to meet successfully *any* V-Belt Drive assignment is possible because Gates runs an *average* of 32,000 hours of testing *every week* on V-Belts alone! (32,000 hours is equivalent to *five years* of life for one belt.)

And the real value to you of such exhaustive testing is this: Laboratory findings are carefully checked by tests made under actual field conditions and the *results* are at once reduced to *usable data* for the design of V-Belt Drives to *perform whatever task may be required!*

Phone for a Gates Field Engineer

If you have a difficult drive to design, or if some drive in your plant is giving trouble, or if you only want to be sure what size and construction of V-Belts will give the most efficient and the lowest cost service on any particular drive—you have only to phone a Gates Field Engineer, *always near you* in all industrial centers.

Just look in your phone book under "Gates Rubber." A Gates Field Engineer will come right to your plant and put at your service the full benefits of Gates V-Belt knowledge and experience *without the slightest obligation!*

EHG-332

Gates VULCO ROPE DRIVES

Engineering Offices and Jobber Stocks IN ALL INDUSTRIAL CENTERS of the U. S. and 71 Foreign Countries

THE GATES RUBBER COMPANY

DENVER, U. S. A.

The World's Largest Makers of V-Belts

20,000 c.f.m. at 110 lbs. pressure

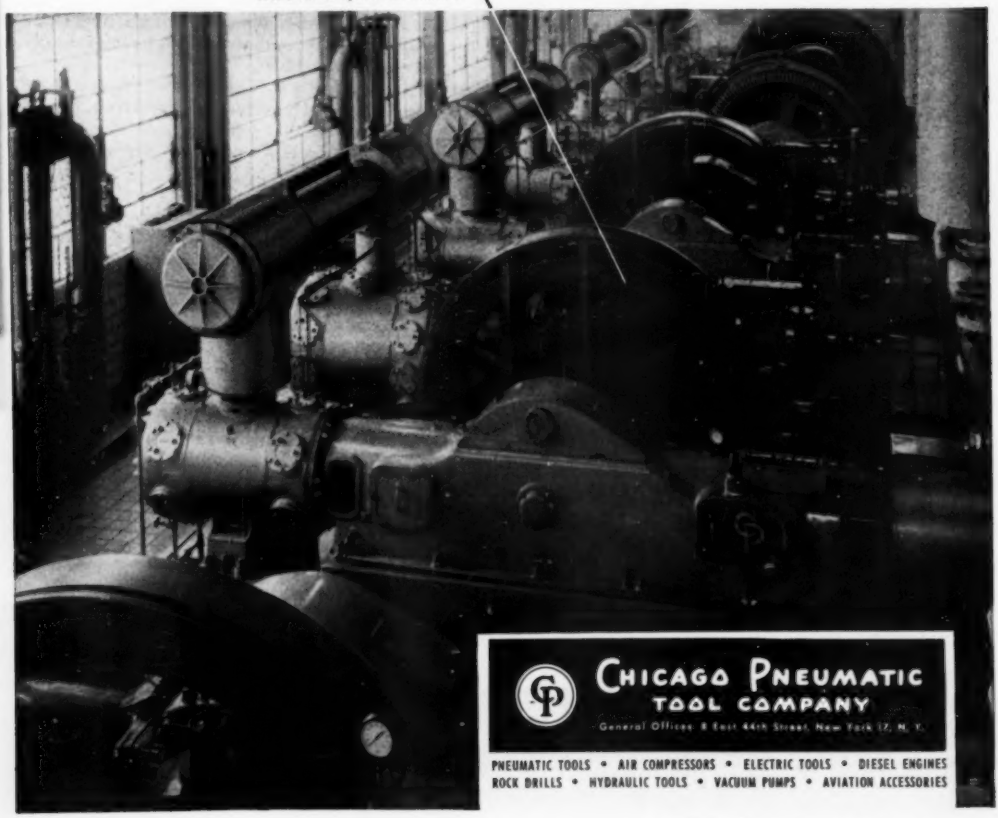
All air requirements of a big automotive plant are met by this battery of five CP horizontal duplex compressors, with a total capacity of 20,000 c.f.m. at 110 lbs. pressure.

The three Type H-DSC steam-driven and two Type O-CE motor-driven units permit a flexibility of operation that assures a dependable supply of air at all times with maximum economy.

Steam-driven compressors are particularly desirable, alone or in combination with electric-driven compressors, where exhaust steam can be utilized for process work or for heating.

CP Fiftieth ANNIVERSARY

Write for complete information



CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 East 44th Street, New York 17, N. Y.

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES
ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

OREGON

ID

Pacific Gas & Electric buys additional

YARWAY

FLAT GLASS GAGES

Pacific Gas and Electric Company—a big factor in sunny California's amazing development—has used Yarway steam plant equipment a long time.

For instance, Yarway Pressure Sealed Flat Glass Gages have been specified in five of their new plants. Yarway glasses have been ordered for pressures from 1475 psi to 2050 psi. P G and E is just one of many companies who have used Yarway Flat Glass Gages for high pressure installations.

Longer gage life results from the "floating assembly" feature. Glass breakage and leakage is reduced. Newest feature is the Yarway Type M Illuminator which causes meniscus at water level to continue to *shine like a star*... even under adverse conditions.

Yarway engineers, conveniently located near you, are constantly working for better, more profitable steam plant operation. A Yarway man can help *you*. Just call him.

YARNALL-WARING COMPANY

109 Mermaid Avenue **Philadelphia 18, Pa.**

Branches in principal cities

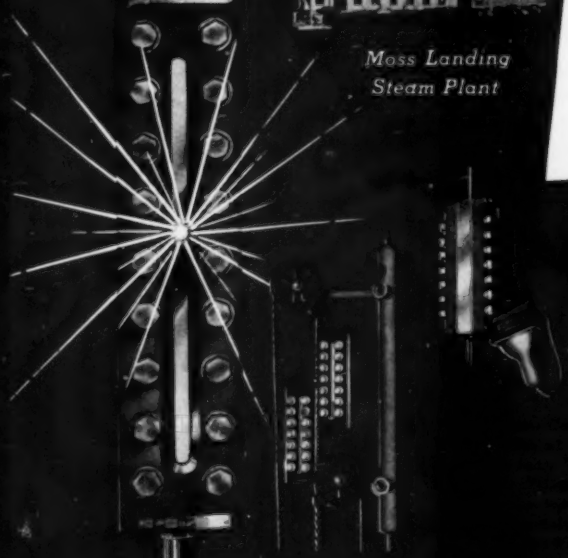
California calls for Yarway again...

Contra Costa Steam Plant

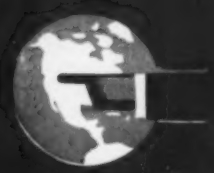
Moss Landing Steam Plant

Kern Steam Plant

ARIZ



YARWAY SERVICE GOES ALL THE WAY...



TERRY

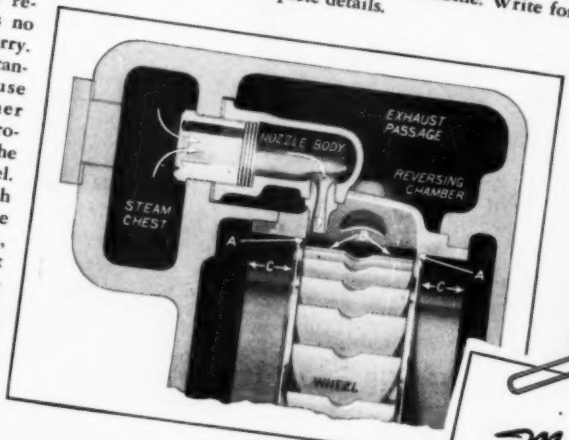
LARGE CLEARANCES take the "worry" out of Turbine Operation

In a Terry Solid-wheel Turbine the power-producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets. This unique design permits unusually large blade clearance—see B in the diagram.

Even if this clearance becomes reduced, there is no real cause for worry. The blades still cannot foul because they are further protected by projecting rims at the sides of the wheel. These rims, which also have ample clearances (AA), will take without damage any rubbing that may occur.

Side clearance, CC, is so large that end-play from external thrust will not damage the wheel. This clearance is one inch or even greater.

Large side and blade clearances are only two of the many features of the Terry Solid-wheel Turbine. Write for complete details.



THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1191

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

COOL HEADS IN "HOT SPOTS" WON'T LET YOU DOWN

On jobs where the air is foul or hot, men can't be blamed too much for letting up now and then. If you want to keep their efficiency and morale high, feed them better air.

Employers have learned the value of putting Coppus Blowers and Ventilators on the job . . . in confined areas and near furnaces or hot processes. The men work faster, do better work, work longer without fatigue — and appreciate the more comfortable working conditions.

Give some thought now to the "hot spots" in your plant. There is a Coppus Blower for practically any requirement — Cable Manhole and Tank Ventilators, Boiler Manhole Blowers and Exhausters, Heat Killers, Shiphold Ventilators, etc. The Coppus "Blue Ribbon" is your assurance of design and construction planned for plenty of severe service. Check and mail the coupon for specific information. Coppus Engineering Corp., Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG.

ANOTHER
COPPUS
"BLUE RIBBON" PRODUCT

COPPUS ENGINEERING CORP., 187 PARK AVENUE, WORCESTER 2, MASS.
Please send me information on the Blowers that clear the air for action.

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fuselages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausters, welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.

NAME .....
COMPANY .....
ADDRESS .....
CITY .....

(Write here any special ventilating problem you may have.)

LOOKING FOR WAYS TO CUT COSTS?

Your only answer may be in using your labor more efficiently..

1. No More Shoveling, Men Are Free For Other Duties...A Tremendous Saving In Man-Power Alone! Then Consider All The Other Low-Cost Advantages....

2. SIDE DUMP ASH PLATES, AN OPTIONAL FEATURE OF CANTON BINFEEDS, ELIMINATE SMOKE, FUMES, DUST IN BOILER ROOM... ASH SPRAY PIPES SIMPLIFY CLEANING.

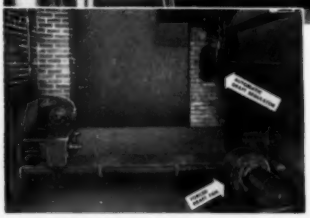
3. COMPLETE CONTROL PANEL ENGINEERED FOR THE JOB IS WIRED AND TESTED AT THE FACTORY — PAYS FOR ITSELF BY SIMPLIFYING WIRING ON THE JOB SITE AND GUARANTEEING PROPER CONTROL OPERATION. MODULATING COMBUSTION AND DRAFT CONTROLS ARE AVAILABLE ON ALL MODELS.

4. AS AUTOMATIC NOW, AS GAS OR OIL.

5. CANTON BINFEED STOKERS HOLD STEAM PRESSURES CONSTANT, REDUCE FUEL COSTS BY PRODUCING MORE HEAT FROM THE FUEL; ALLOW CHEAPER GRADES AND SIZES OF COAL TO BE USED EFFICIENTLY.

6. NO NEED FOR SEPARATE INCINERATOR WITH CANTON SIDE DUMP BINFEEDS, AS THEY PROVIDE FOR BURNING REFUSE.

7. FLAT PLATE TOP OF WORM CASING CAN BE INSTALLED AT FLOOR LEVEL, WHEN DESIRABLE, FOR TRUCKS OR TRAFFIC TO PASS OVER.



New Canton Binfeed with coal conveyor rear of boiler. Note fan and automatic draft regulator are also at rear of boiler, out of the way.

LOOK AT THE NEW CANTON STOKER DEVELOPMENTS

Binfeed Stokers cut costs immediately for every heat and power demand by allowing more efficient use of labor. High wages, going higher, have speeded up the need for automatic handling of coal—the lowest price fuel. It will pay to look into the new developments by Canton Stoker, specialists in COAL FIRING, HANDLING and CONTROL equipment. Representatives in principal cities of the U. S. have complete information, or write direct.

Flo-Tube Coal Conveyors fill one or more hoppers direct from bin or pile. Are also used horizontally as in picture at right, with gate valves to control hopper feeding.

For larger Boilers, ample active burning area is provided by Canton's newest Tuyere design with measured air graduation and fin-cooling ribs. Dead plate type illustrated here . . . also available in side ash dumping type.

Ever see a neater installation? This photo is NOT RETOUCHED. It is Canton Stoker installation, St. Mary's Hospital, Niagara Falls, New York. Hoppers are fed horizontally, direct from bin by screw conveyors.

New Canton "SINGLE-SIDE-DUMP" model, engineered and built for narrow boilers.

"TURBO-AIRE" JETS — for smoke abatement, firing efficiency.

WRITE FOR NEWEST BROCHURE **on Binfeed Stokers. It contains blue-prints and plan of a model stoker installation. A great help in planning or remodeling.**

CANTON STOKERS

CANTON STOKER CORPORATION

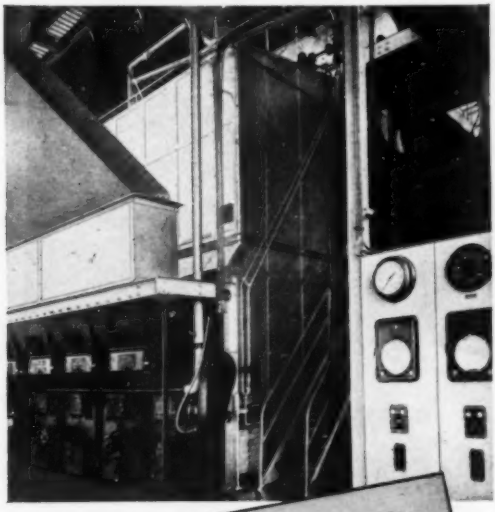
497 ANDREW PLACE S. W. CANTON, OHIO

"HOW WE SAVE MORE THAN $90,000 A YEAR—

BY BURNING COAL THE MODERN WAY!"

says W. H. FISHER, Plant Engineer, Kerr Bleaching and Finishing Works, Concord, North Carolina.

"Powering our plant used to take nine boilers—now *one* does the same job *using 30% less fuel!* 6 firemen now do the work of 18—thanks to modern coal-handling equipment and automatic controls. That's why we say, you can't beat bituminous coal burned with modern equipment."



Above is a view of the plant's modern, space-saving coal-storage silo. To the left is a close-up of the firing aisle, showing the spreader stoker and the main control panel. Coal handling is automatic and dust-tight throughout. Automatic controls regulate firing, drafts and feed-water—give maximum efficiency at lowest cost.

If you operate your own steam plant, you can't afford to ignore these few down-to-earth facts!

COAL in most places is today's lowest-cost fuel.

COAL resources in America are adequate for all needs—for hundreds of years to come.

COAL production in the U. S. A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

Burning coal the modern way can save *you* money, too! First, labor costs can be cut to a minimum with up-to-date coal- and ash-handling equipment. On top of that, today's combustion installations give you 10 to 40% more power from each ton of coal than was possible a few years ago!

If you're planning to modernize, or if you're building a new plant, call in a consulting engineer. He'll show you how you can get big savings by burning coal in a modern plant designed to meet your *specific* needs.

America's coal reserves are virtually inexhaustible; America's coal industry is the world's most productive and efficient. That's why coal has a future dependability of supply that no other fuel can offer. That's why, of all fuels, the price of coal is most likely to remain stable.

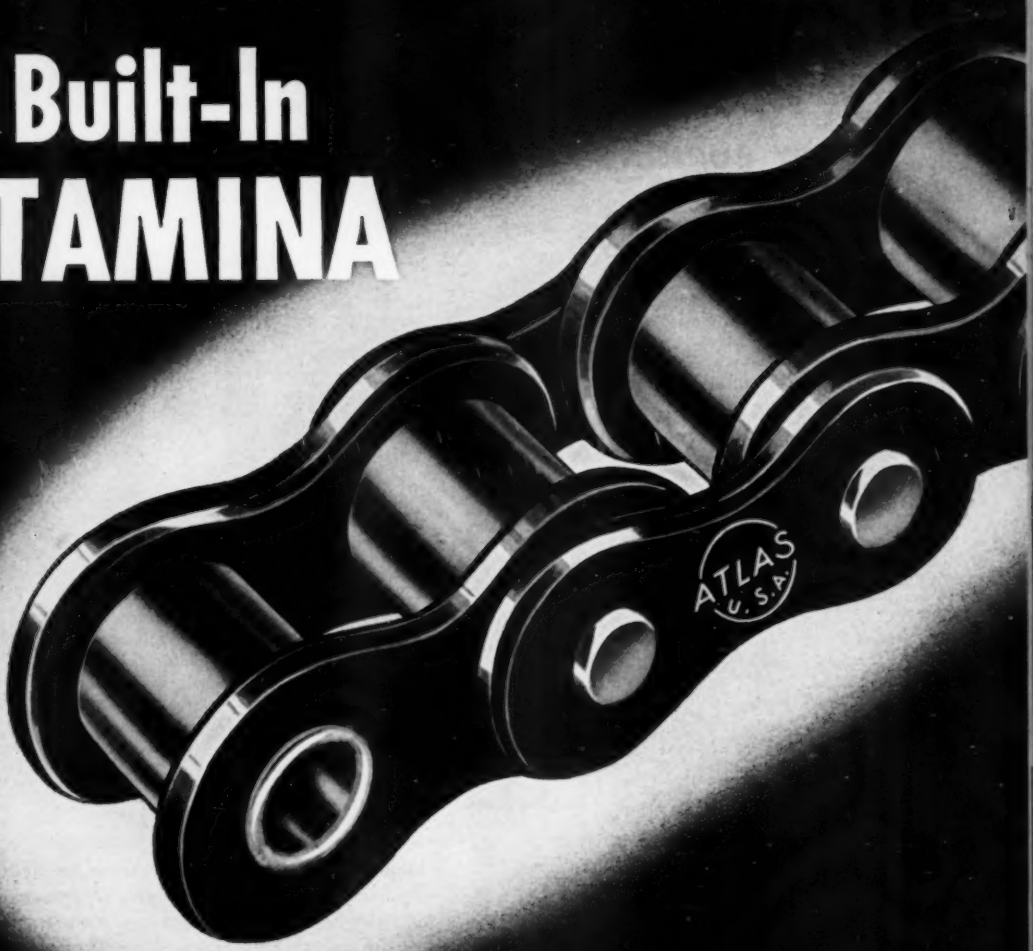
BITUMINOUS COAL INSTITUTE

A Department of National Coal Association, Washington, D. C.

FOR HIGH EFFICIENCY FOR LOW COST

YOU CAN COUNT ON COAL!

Built-In STAMINA



. . . ANOTHER REASON FOR THE "SUPER-LIFE" OF ATLAS CHAIN

Every component in a link of roller chain plays an important part—the bushing, the pin, the link and inside plate, the roller. Each must pull its share of the load—each must be heat-treated so that it takes more than its share of the punishment. Otherwise, premature chain maintenance and replacement.

The Atlas Nicarb Process used for case hardening bushings and pins is one big reason for the stamina of Atlas "Super-Life" Chain. Nicarbing provides an outer surface strongly bound to the core of the steel which provides greater strength and wear resistance.

The link plates and rollers are also made of tough, heat-treated alloy steel; their uniformity achieved with automatic electronic instruments which control the furnaces.

Yes, every component part of Atlas "Super-Life" Chain is made to have the maximum of inherent strength. This means greater efficiency—greater economy—on every drive!

Investigate today the chain that keeps on running after ordinary chain is out of service. Write: ATLAS CHAIN and MANUFACTURING COMPANY, Kensington & Castor Avenues, Philadelphia 24, Penna.

"SUPER-LIFE"

ATLAS CHAIN

ALL FORGED STEEL

Edward

INSTRUMENT VALVES

Lowest Cost Valves for Their Rating!

Standardize on Edward instrument valves—forged steel, yet their price is comparable to ordinary bar-stock valves.

Edward instrument valves are top-quality in every design detail—easy-grip T-handle . . . bronze yoke bushing . . . forged steel one-piece outside screw yoke . . . forged steel corrosion-resistant EValized packing gland . . . EValloy 13% chromium stainless steel stem-disk with needle point for close flow control . . . forged steel EValized gland bolts that swing out of the way for easy repacking . . . heat resistant die molded EValpak packing.

And look at this versatility—

★ STEAM, WATER, OIL or GAS PRODUCT PROCESS LINES

Edward instrument valves fit into any piping system. Globe or angle, sizes ⅛", ¼", ½", ¾" and 1".

★ HIGH TEMPERATURES or HIGH PRESSURES

Rated up to 6000 lb at atmospheric temperatures, or up to 1500 lb at 1000 F.

★ STANDARD or CORROSIVE SERVICE

Available in carbon steel or 13% chromium bodies and trim.

★ TYPICAL USES

Orifice Meters	Regulators
Instrument Panels	Gage Lines
Oil Field Xmas Trees	Drip and Drain Lines
Hydraulic Systems	Pressure Recorders
Vent Lines	Corrosive Lines

Get the full story on Edward instrument valves—*the lowest cost valves for their rating.* Write for Bulletin 491.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
40 WEST 144TH ST. EAST CHICAGO, INDIANA

Another Product

American Blower . . . a time-honored name in air handling

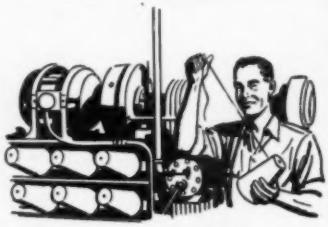
Phoenix, Ariz., has a conveniently located American Blower Office to provide you with data and equipment for air handling. You can reach American Blower in Phoenix by calling 8-2793. In other cities, consult your phone book.

CAPITOL COMFORT

All of us can feel a bit prouder now that our most famous of buildings, the U.S. Capitol, has been renovated. The job also included the power plant where modern new American Blower Mechanical Draft Fans replaced the obsolete equipment. High static efficiency, low RPM, low tip speed and low inlet velocity are but a few of the many reasons these fans enjoy such wide acceptance. Our conveniently located branch offices, staffed with competent engineers, will be glad to furnish you with specific data.

CLEAN AIR

Soap manufacturers strive continually to achieve high standards of purity in their products. But industrial dusts raise hob at various stages of processing. American Blower equipment has helped several soap companies overcome this problem. American Blower fans and air washers, for example, are highly effective. The fan supplies an ample supply of circulating air. The air washer cleanses, purifies and freshens the air while removing dust and water-soluble odors.



YARN ABOUT YARN

A textile manufacturer was continually changing pulleys or setting the machine rate on his ring-spinning frames to fit the material that worked at the lowest speed. He'd heard about American Blower Gyrol Fluid Drives and decided to try them. Results were amazing. Gyrol Fluid Drive permitted a higher output within safe limits of the material, allowed spinning frames to start gradually with less yarn breakage. For your business, wouldn't smooth power transmission and adjustable speed control be a distinct advantage?

YOUR BUSINESS

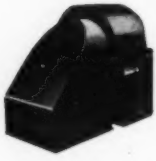
If your needs call for heating, cooling, drying, air conditioning, or air handling equipment, you'll find American Blower an excellent source of supply. For data, phone our nearest branch office.

Unit Heaters

Mechanical Draft Fans

Air Conditioning Equipment

Gyrol Fluid Drives

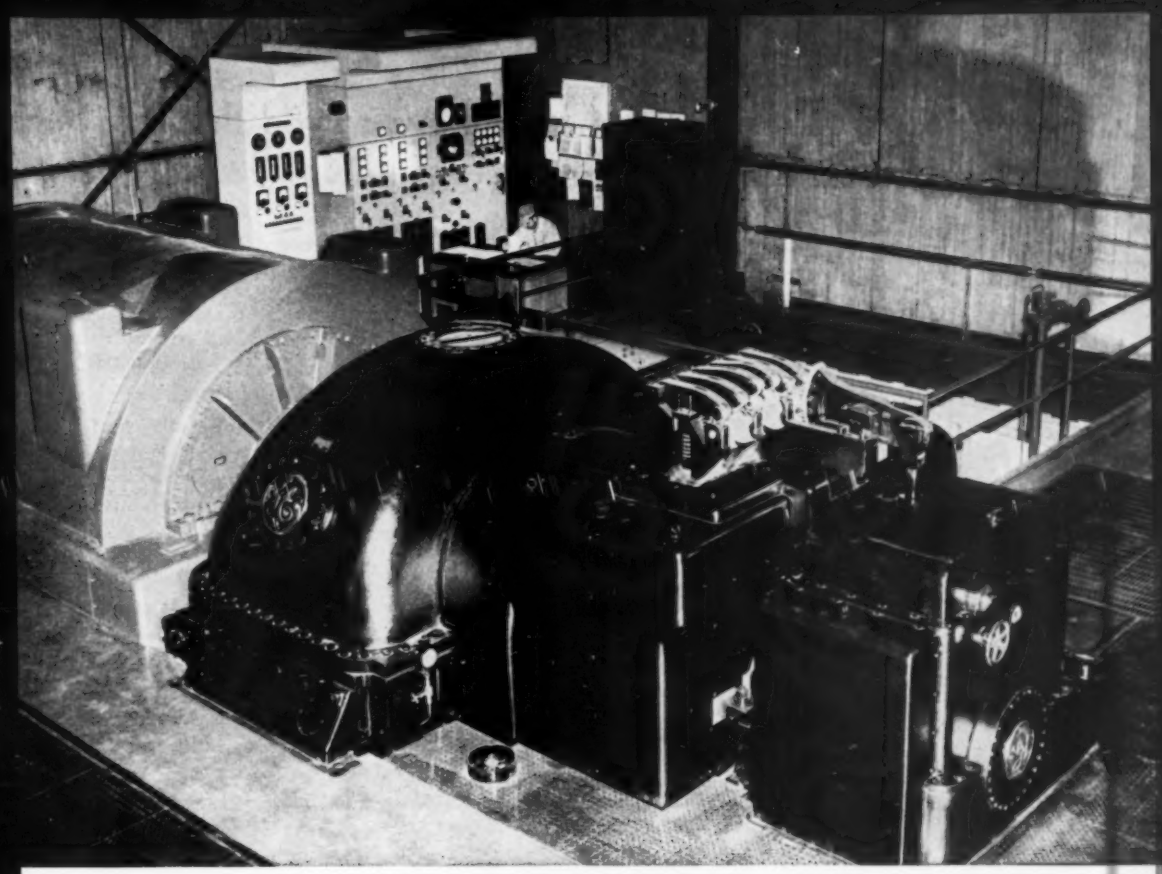


Utility Sets

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

YOUR BEST BUY **AMERICAN BLOWER** AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON



Assures trouble-free lubrication for life of new turbine

There is good reason to believe that this new 15,000-KW turbine at Ottertail Power Company's Ortonville, Minnesota, plant will never have to be shut down for oil replacement, oil system cleaning, or because of oil acidity troubles. The basis for this conviction can be found in the company's own experience with NONPAREIL Turbine Oil, lubricant for the new unit.

Since 1931, the Ottertail Power Company has put NONPAREIL into several turbines. In one of those first units, NONPAREIL has now served for 21 years, and the original fill of oil has never needed to be replaced. Although the lubricant has not been removed for treating, it has maintained a neutralization number below 0.09 mg. KOH/gm. The oil system has not required cleaning.

With this evidence of long life is the written guarantee given with each fill of oil that NONPAREIL will last as long as the turbine and will maintain a neutralization number below 0.15 mg. KOH/gm.

You can assure trouble-free lubrication for the life of your turbines by using NONPAREIL Turbine Oil. Phone your Standard Oil Company (Indiana) office for the services of a Standard lubrication specialist. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

NONPAREIL
TRADE MARK
Turbine Oil

STANDARD OIL COMPANY

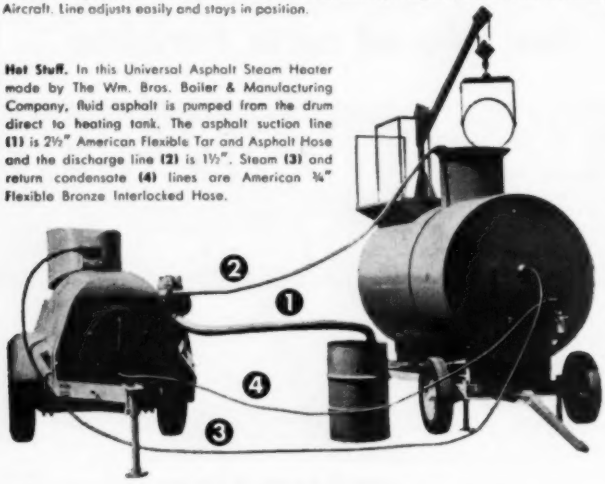
STANDARD (Indiana)

How in the world would **you** have solved these connector problems?

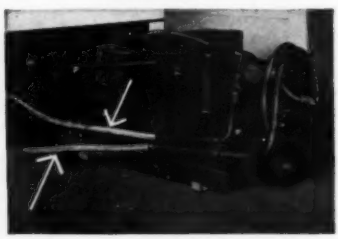
Coolant gets a new twist. A quick twist, and American Flexible Metal Tubing conveys coolant to just the right spot on this special lathe which machines jet engine parts at Pratt & Whitney Aircraft. Line adjusts easily and stays in position.

Would you have relied on costly, clumsy, rigid piping? Thrown up your hands? Or – like the resourceful designers of these three machines – would you have used flexible metal tubing? In each case American Flexible Metal Hose or Tubing filled the bill . . . and cut operating costs.

Your product, too, may need versatile, flexible American Metal Hose. If it must move, bend, or vibrate, let us show you the right connector...designed to absorb vibration, connect moving lines, or to be assembled in close quarters, while resisting heat, cold, pressure and corrosion in conveying liquids, gases or semi-solids. Write for Bulletins SS-50 and CC-300 which give technical details and many application histories. The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn. In Canada: The Canadian Fairbanks-Morse Company, Ltd.



Hot Stuff. In this Universal Asphalt Steam Heater made by The Wm. Bros. Boiler & Manufacturing Company, fluid asphalt is pumped from the drum direct to heating tank. The asphalt suction line **(1)** is 2½" American Flexible Tar and Asphalt Hose and the discharge line **(2)** is 1½". Steam **(3)** and return condensate **(4)** lines are American ¾" Flexible Bronze Interlocked Hose.



Pull-out is a push-over to repair. Tyler Fixture Corp. neatly solved the problem of permitting quick inspection and easy repair of the refrigerating unit in their freezers. Entire unit pulls out, yet refrigerant lines remain connected – thanks to American Seamless Flexible Bronze Tubing.

ANACONDA

wherever connectors must move

American **FLEXIBLE METAL HOSE AND TUBING**

Announcing

THIS SALT-SPLITTER SYSTEM removes both alkalinity and hardness by means of two resin beds in one tank. Needing only inexpensive salt — no acid — for regeneration, it offers these advantages:

1. Permits operation at alkalinities approaching zero, since no acid is present to damage equipment or produce acid water.
2. Eliminates costly rubber- and lead-lined tanks and piping.
3. Simplifies disposal of spent regenerant.
4. Provides complete safety for operating personnel.

Users of sodium zeolite softeners who find them unsuitable because of the high alkalinity of the effluent or who may be by-passing raw water for boiler make-up should definitely investigate the possibilities of incorporating this system into present installations.

For a concise explanation of the operation of this new combination of two proven water-conditioning methods, get a copy of the new Allis-Chalmers bulletin, 28X7808. Just fill in and mail the coupon.

Allis-Chalmers
Milwaukee 1, Wisconsin

Please send Bulletin 28X7808 describing alkalinity reduction by ion exchange.

Name

Title

Company

Address

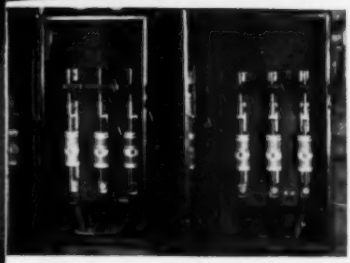
City State A-3615

ALLIS-CHALMERS

Water Conditioning

✓ EQUIPMENT ✓ CHEMICALS ✓ SERVICE

for FUSE ECONOMY... use ECONOMY FUSES



YOU SAVE 3 WAYS!

FIRST—with "ECONOMY DE-LAY" Renewable Fuses you save money every time you have a current "blow". Simply remove the blown link and replace it at the cost of only a few cents with a new, "ECONOMY DE-LAY" Renewal Link in the same cartridge.

SECOND—you save because of the short time required to make this replacement—and time is money.

THIRD—you save by reducing "down time" on machines—because an inexpensive carton of Economy Fuse Renewal Links kept on hand 24 hours a day, answers fuse renewal requirements *immediately*.

Your Electrical Wholesaler has "ECONOMY DE-LAY" Renewable Fuses and Renewal Links in stock.

Ask for the Economy Catalog and Price List.

ECONOMY DE-LAY RENEWABLE CARTRIDGE FUSES

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ECONOMY FUSE AND MFG. CO., 2717 GREENVIEW AVE., CHICAGO 14, ILLINOIS REPRESENTATIVES IN ALL PRINCIPAL CITIES

8730

Plan Your Boiler Installation this Way..

...to Balance Load Factor with Low Investment
...to Meet Present Needs and Future Expansion...

CLEAVER-BROOKS self-contained steam boilers are the answer to both present and future steam needs. You can install Cleaver-Brooks boilers in units to fit your present steam capacity requirements . . . keeping your investment at a minimum and your boiler efficiency at a maximum. Here's how it works . . .

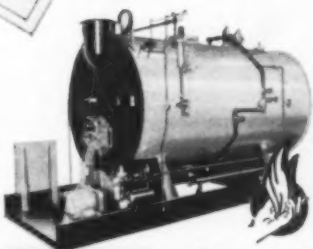
Your initial Cleaver-Brooks boiler installation is made in the size or capacity to fit your present steam load — this assures full use now at top efficiency and low capital investment.

As increased steam needs arise, additional Cleaver-Brooks boilers can be added to keep pace with your expanded requirements.

With this flexible program, you have the greatest return from your boiler investment — minimum original cost and lowest operating cost. Your boilers are always operating at maximum efficiency (80%) over the entire working range (30 to 100%).

Cleaver-Brooks self-contained boilers are ideal for multiple installations because of their compactness, low headroom requirements, fast installation, automatic operation, range of sizes. Available in standard models—15 to 500 hp.; 15 to 250 psi; gas, oil or combination gas and oil fired units.

Get all the story — write today for latest catalog.



Cleaver-Brooks

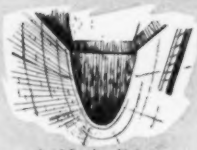
Dept. H-302 E. Keefe Ave., Milwaukee 12, Wis., U.S.A.
Cable Address: Clebro-Milwaukeewis

Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

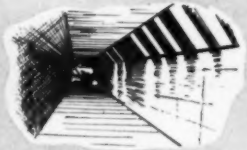
WHERE TO USE LUMNITE IN POWER PLANTS

Steel Stack Linings

Ash Pit and Cinder Catcher Linings

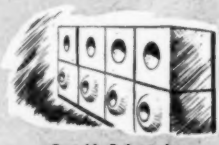


Coal Bunker Linings



Flue and Dust Linings

Overnight Structural Concrete



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Southern's Seminole mine, Lenzburg, Illinois, on the I. C. Railroad. Typical of Southern's many modern operations.

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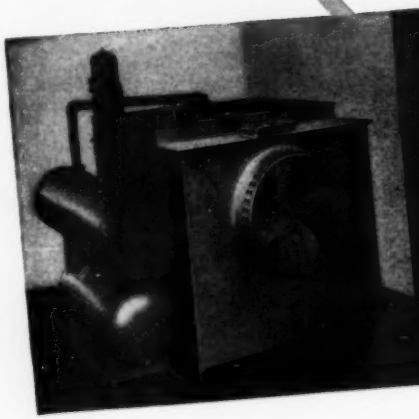
New

SAVES WATER and CUTS MAINTENANCE COSTS . . .

Illustration shows two views of a 35 ton Condenser Tower prior to partial disassembly for shipment.



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SHOP FITTED:

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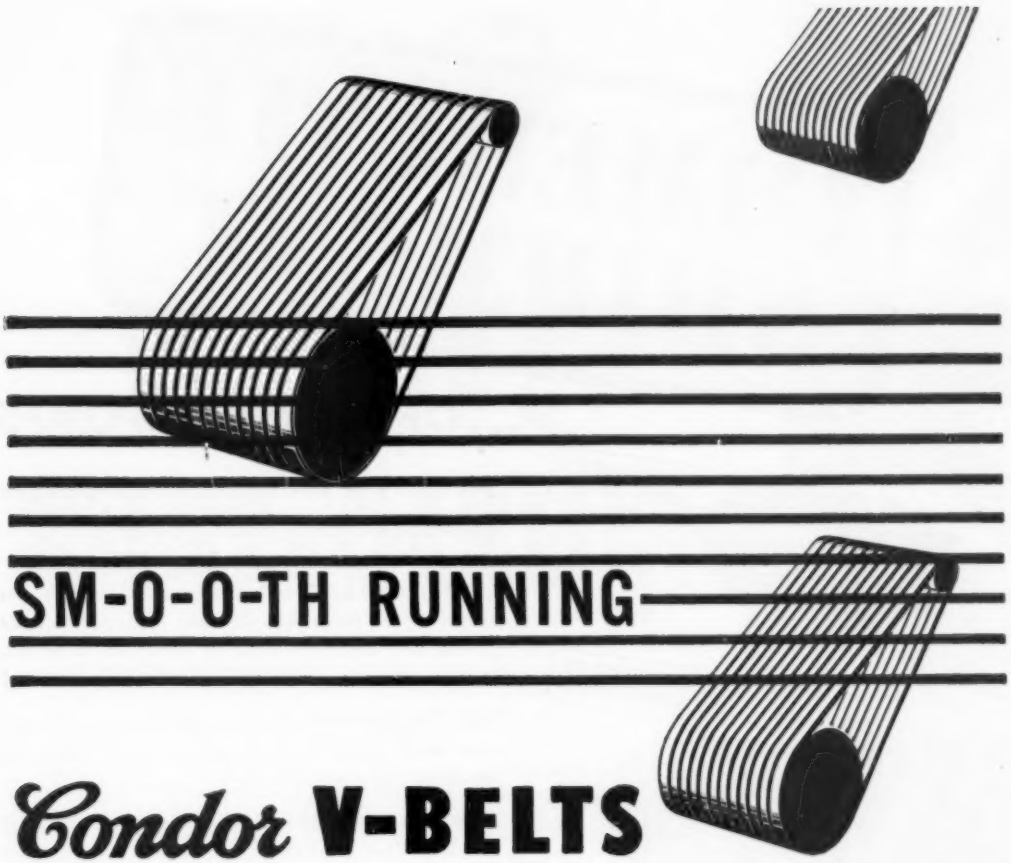
BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.



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You get long belt life and low belt costs with Condor V-Belts because they are the smoothest running V-belts made. These are the Raybestos-Manhattan engineering reasons . . . Pulling section is micro-positioned, where engineering says it should be . . . Straight sidewalls give more grip, less slip, longer life . . . Every part of belt is precision-balanced. Other advantages are described in Bulletin 6868D. Write for a copy . . . or call your R/M Distributor • We can show you also how equally good engineering in R/M hose, conveyor and transmission belts helps "smooth out" production problems.

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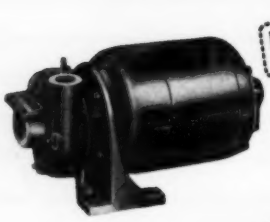
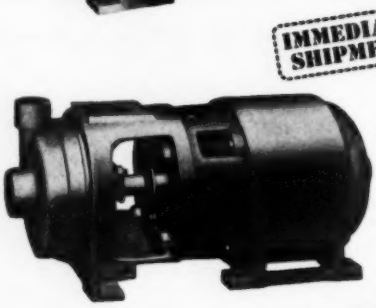
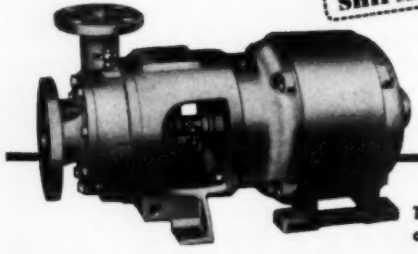
...OF I-R MOTORPUMPS







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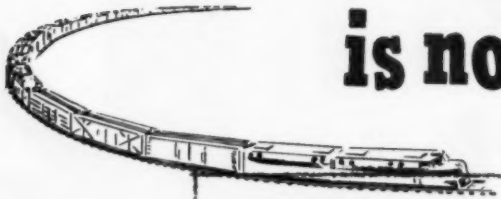

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YARWAY the steam trap
designed with more production in mind

Plant Manager D. B. Crews, left, congratulates Consulting Engineer M. A. Nishkian, designer of entire generating and distribution system

This exterior photograph shows the front entrance to the boiler house

THIS COOPERATIVE STEAM PLANT SERVES FIVE TERMINAL ISLAND CANNERIES

Replacing five obsolete boiler plants with one generating system, styled to the concept of utility operation, requires intelligent planning and competent engineering but benefits at this installation include 30 per cent lower steam costs

M. A. NISHKIAN, *Consulting Engineer*
A. D. SKILLMAN, Jr., *Mechanical Engineer*
M. A. Nishkian & Co.

WHEN MEMBERS of a highly competitive industry join together in a cooperative enterprise involving utility services, it is really a newsworthy occurrence. Such an arrangement has been organized by a group of five independent fish canners on Terminal Island, Los Angeles, Cal.

Early in the spring of 1950, these progressive canners, motivated by the proximity of their plants and the age and condition of their boilers, decided to investigate the possibility of erecting and operating a cooperative steam generating plant. This proposed plant would supply process steam for canning operations at all the affiliated plants, but no power generation was contemplated. After establishing this basic plan, the companies retained a consulting engineer to conduct studies and report if the system would be economically feasible.

Due to the rapid growth of the canneries through the years, records of past performances for the existing boiler plants were rather meager. In most cases, no separate cost data covering operations of the steam systems were available. This necessitated establishing a method for estimating total steam consumption for the plants that were to be included. The engineers decided that the steam demand would vary directly with the weight of fish landed in the Terminal Island area. Since the existing boiler plants operated at maximum capacity when fish landings were heaviest, it was possible to establish a demand curve for the canneries on a yearly basis.

Past records of fish landings compiled by the Bureau of Marine Fisheries of the State of California were then examined. The information obtained was correlated with maximum output of existing boiler plants to establish a curve indicating the probable increase in demand that could be expected in the future. These curves determined the present and future capacity requirements of the proposed generating plant.

When preparing comparative production costs for the existing method of operation and the eproposed consolidated system, total annual steam output of each individual boiler plant had

to be estimated to determine probable load distribution among the cooperating canners. This was a difficult task, as detailed records of boiler operation were not available at any of the companies. However, by using total fuel consumption, estimated boiler efficiency and other miscellaneous information, unit steam production costs of each separate plant were established. These individual results were then totaled and a system unit cost obtained.

Similar information covering anticipated performance of the contemplated plant was determined in the same manner, except that an addition to allow recovery of the capital investment over a 15 yr period was included. Comparing these data with the previous calculations indicated it would be possible to produce steam in the proposed plant for 30 per cent less than the average cost that prevailed in the existing plants. Furthermore, greater average annual savings could be expected at the end of the 15 yr retirement period.

In October 1950, the engineers submitted a report of their survey to five canneries, namely, California Marine Curing & Packing Co., French Sardine Co., South Coast Fisheries, Inc., Terminal Island Sea Foods Co., Ltd. and Van Camp Sea Food Co., Inc. Representatives of these companies met and formed an organization to be known as Canner's Cooperative Steam Co., Inc. One official from each affiliate was elected to a board of directors that was created to manage the steam company, and this group decided steam would be supplied to each participating canner at cost. They also commissioned the consulting engineers to prepare plans and specifications in accordance with the submitted recommendations and supervise plant construction.

Ground was broken for the new plant during April of 1951, and construction progressed at a rapid rate. The first steam generator was placed on the line Oct. 15, 1951, even though erection of the other boilers was not 100 per cent complete. Installation of the final unit was completed in December, and the entire plant was officially ready for service Dec. 15, 1951.

Demand data obtained in the initial report established the fact that the maximum steam load was 285,000 lb per hr with canning operations at current levels. From available records of past fish catches, a maximum future demand was estimated which indicated consumption might reach 380,000 lb per hr within 10 yr. In view of these conditions, the steam plant was designed to include four boilers initially, located symmetrically along a 26 ft wide firing aisle, with space provided for future erection of two additional units.

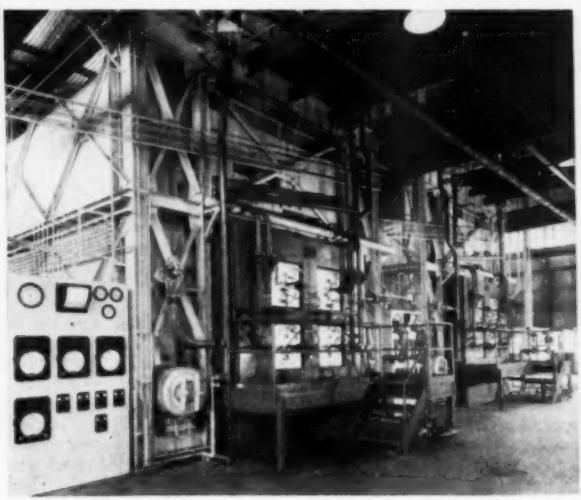
Each steam generator has a continuous duty rating of 80,000 lb per hr and can produce 100,000 lb per hr for 4 hr peak demand periods. This output permits operation with three generators on the line and one in reserve for nearly all anticipated load conditions. Should future expansion become necessary due to new members joining the cooperative or increased production at the existing plants, steam supply will be maintained by operating all four units while the two additional boilers are being installed.

All steam generators are three drum bent tube units of suspended construction with fully water cooled furnaces designed for a maximum heat release of 30,000 Btu per cu ft per hr when firing either bunker C oil or natural gas. The pressure parts are designed for 300 psi and normal operation supplies 275 psi saturated steam at the boiler outlet. Each unit is equipped with air actuated combustion controls and instrumentation mounted on individual control panels adjacent to the boilers. In addition, a master control panel was provided at the end of the boiler house where it is visible from the superintendent's office.

To insure long life and freedom from maintenance, the boilers are provided with suspended type settings. In the type of setting employed, the burner and the target walls are constructed of 7 in. thick refractory blocks of a patented design so arranged that all joints are completely offset and each tier of blocks is separately supported by special metal castings and structural members. Side walls are constructed of 2½ in. thick refractory supported by castings and studs welded to the water wall tubes. Front and target wall refractories are backed by 1 in. of plastic insulation, a 6 in. air space, a 1 in. thick marine board panel and finished with a 3/16 in. steel casing. Tube suspended walls include 2 in. of block insulation covered with metal lath, troweled plastic insulation and an exterior surface of canvas fabric.

Air preheaters provided for the boilers are of the two pass, counterflow, tubular type, designed to cool

Four boilers with individual control panels have been installed. Space was provided for future erection of two additional units



A two stage hot process softening system is used to treat raw water entering the plant

the exit gases from 680 to 430 F while raising the air temperature from 80 to 378 F when the units are operating at 100,000 lb per hr. As the boiler load varies directly with the amount of fish brought into the canneries, wide fluctuations occur within very short periods of time. To prevent condensation and subsequent corrosion during periods of low load, recirculating ducts from the air preheater outlets to the forced draft fan inlets have been provided with dampers for controlling the recirculated air volumes. At a load of 25,000 lb per hr, recirculating 50 per cent of the air that has passed through the preheater produces an exit air temperature of 308 F and a corresponding gas temperature of 255 F.

Four combination burners for firing gas or oil have been furnished for each generator. The oil burners are retractable mechanical atomizing type with constant differential pump control and

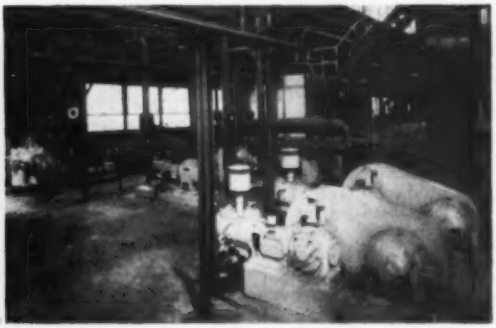
steam turbine drives except the FD and ID fans for one generator that are equipped with combination steam turbine and electric motor drive. Inlet vanes on the forced draft fans and outlet dampers on the induced draft fans are automatically positioned by the combustion controls to provide the necessary regulation of air and gas volumes. Each forced draft fan is designed to deliver 26,400 cfm of 80 F air against a static pressure of 10 in. wg while each induced draft fan handles 49,500 cfm of 430 F gas at 4.25 in. wg static pressure.

Unlike most steam generating plants where an appreciable amount of return condensate can be expected, this plant operates with practically 100 per cent makeup water. Due to the nature of various fish canning processes nearly all condensate is contaminated and recovery is not economical. This created design problems as water sup-

from this tank and discharge the raw water through the blowdown heat exchangers and the deaerating section into the hot lime process softener. Here the raw water is reduced to an average of approximately 20 ppm total hardness before flowing by gravity through the filter tanks. Then two centrifugal booster pumps, one steam and one electric driven similar to those previously mentioned, pump the water from the filters, through the zeolite softeners to the three boiler feed pumps. Two of these pumps are turbine driven while the third uses motor drive.

After-treatment consists of feeding phosphate and lignin derivative into the boiler feed pumps with ball feeders. Phosphate concentration is maintained at about 50 ppm while lignin derivative is added at a rate of approximately six 12 oz ball briquettes per million lb of steam produced. The final effluent has a zero hardness, and inspec-

Most of the auxiliary equipment is turbine driven as low pressure steam is required for feedwater heating



Natural gas is normally fired but oil is circulated continuously to allow rapid transfer in emergencies

receive oil from two gear type fuel oil pumps that are connected to operate singly or in parallel. Three fuel oil heaters of the multi-film steam type that are similarly connected have also been provided.

Due to cost considerations, the boilers are operated on gas whenever possible but high domestic demands during cold weather often require shifting from gas to oil with less than 15 min notice. In order to meet these requirements, a small amount of fuel oil is circulated continuously from the tank, through the main and constant differential pumps and back to the fuel oil tank. This assures a supply of heated oil at the burners, and switching from gas to oil is merely the act of lighting of the oil burners and shutting off the gas.

Individual constant speed forced and induced draft fans have been furnished for each boiler. All fans have

ply for the plant consists of any one or combination of three waters of widely different analyses ranging from 136 ppm maximum to 30 ppm minimum total hardness. These waters also contain silica and sulfates in concentrations as high as 40 ppm and 320 ppm respectively.

In order to keep continuous blowdown within reasonable limits and to provide safe water under all possible conditions, a two stage hot lime-hot resinous zeolite softening system was installed. This system, the first of its kind on the west coast, was designed to soften and deaerate 400,000 lb per hr at maximum capacity, and all functions including desludging, backwashing and lime feed are automatic.

Raw water enters the plant through a backflow protection valve and flows into a 25,000 gal service tank. Two centrifugal booster pumps, one motor and one turbine driven, take suction

tion of the boilers after six months of operation shows absolutely no signs of any internal deposits.

Though the various canneries are located in the same general area, a sizeable distribution system was necessary to provide steam to all of the participants. Several methods of distribution were considered including systems completely overhead, partially overhead and partially underground, and totally underground. Local ordinances were studied and installation costs were estimated before a totally underground system was selected.

Two loops of 14 in. diam pipe, nozzled into a single 16 in. diam header leading from the boiler plant, were installed in a single trench located under existing streets. This installation was extremely difficult as utility services were already in place, which prevented the use of conventional expansion loops. Therefore, expansion

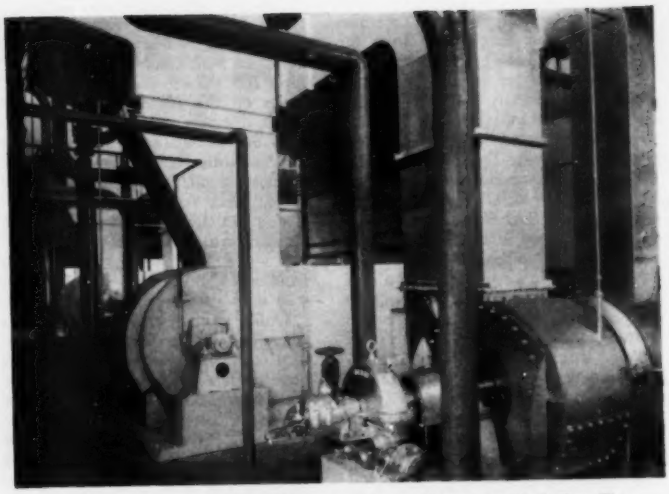
in the lines is absorbed by diaphragm type expansion joints that were located in underground manholes at approximately 125 ft intervals along the distribution loops. Exclusive of individual tie-ins at the canneries, the complete system contains a total of 5470 ft of pipe and is designed to carry steam at 275 psi pressure.

Much of the area served by the distribution system is on "made" land where the water table is quite near the surface and subject to tidal fluctuations. To prevent corrosion and provide good thermal insulation, all piping has been covered with a prefabricated waterproof casing that consists of two aluminum jackets lined with asphalt saturated felt, which contain perlite insulating material. Field joints were made by clamping two semi-circular segments together and then mopping the exterior with a waterproof coating.

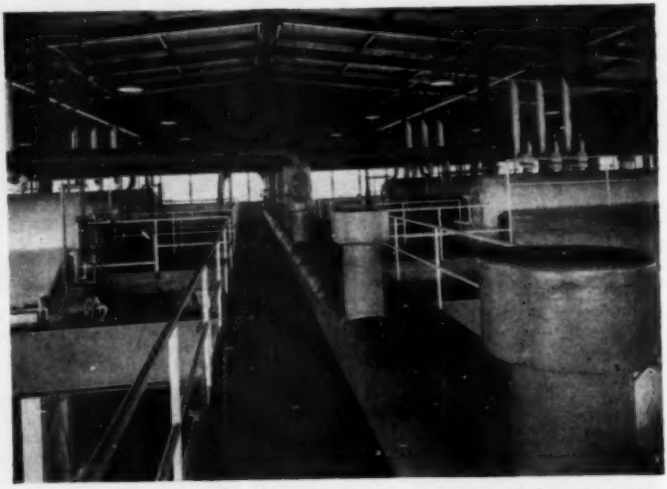
Individual pressure reducing stations have been provided at each cannery to reduce the pressure from approximately 275 psi to an average of 125 psi. Tie-ins are connected on alternate side of the distribution loop to prevent local starvation that could occur if feeders were in close proximity on the same line. In addition, meters have been furnished to record steam consumption over a seven day period.

The total operating force for the new plant consists of 7 men, including the Plant Manager, who handles all functions of the cooperative under supervision of the board of directors. One man on each shift operates the equipment under the direction of the Chief Engineer, who also supervises the activities of the relief operator and a maintenance engineer, who complete the personnel complement.

Since the plant has been in operation a relatively short time, complete cost data has not been established for all conditions. However, the guaranteed efficiency of 80.11 per cent at a rating of 100,000 lb per hr when firing gas has been exceeded, which indicates the canners will enjoy the benefits of a successful installation.



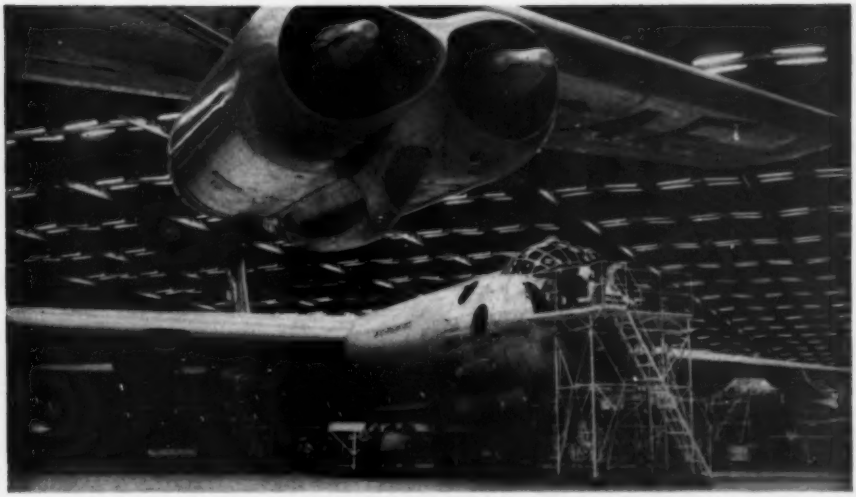
FD and ID fans and air preheaters were supplied for each boiler. The FD fans have recirculating ducts to prevent condensation at low loads



One 16 in. header in the boiler house feeds both loops of the primary steam distribution system, which contains 5470 ft of underground pipe

PRINCIPAL EQUIPMENT IN THE STEAM PLANT

Steam generators	Union Iron Works
Boiler settings	Bigelow-Liptak Corp.
Soot blowers	Diamond Power Specialty Co.
Water column	Reliance Gauge Column Co.
Safety valves	Consolidated Brass Co.
Non-return valves	Edward Valves, Inc.
Air preheaters	Union Iron Works
Forced draft fans	American Blower Corp.
Induced draft fans	American Blower Corp.
FD and ID fan turbines	The Terry Steam Turbine Co.
FD and ID fan motors	General Electric Co.
Air compressors	Worthington Corp.
Boiler feed pumps	Worthington Corp.
Boiler feed pump turbines	Worthington Corp.
Boiler feed pump motors	General Electric Co.
Water booster pumps	Worthington Corp.
Water booster pump turbines	The Terry Steam Turbine Co.
Water booster pump motors	General Electric Co.
Combination burners	Peabody Engineering Co.
Fuel oil pumps	Sier-Bath Gear & Pump Co. Inc.
Fuel oil pump turbines	The Terry Steam Turbine Co.
Fuel oil pump motors	General Electric Co.
Fuel oil heaters	Coen Co.
Pressure reducing valves	Fisher Governor Co.
Feedwater regulator	The Bailey Meter Co.
Hot process softeners	Graver Water Conditioning Co.
Deaerating heater	Graver Water Conditioning Co.
Continuous blowdown system	Graver Water Conditioning Co.
Combustion control	The Bailey Meter Co.
Boiler instrumentation	The Bailey Meter Co.
Pressure gages	Manning, Maxwell & Moore, Inc.
Valves and fittings	Crane Co.
Couplings	Koppers Co.
Expansion joints	Solar Aircraft Corp.
Pipe insulation (distribution system)	Pacific Ryolex Co.
Pipe insulation (exposed)	Union Asbestos & Rubber Co.



Increased power demand and resistance welders threatened to overload the electrical distribution system

CONVAIR'S THREE-PHASE WELDERS EASE ELECTRICAL DISTRIBUTION PROBLEMS

Large resistance welders are, in effect, specialized substations producing low voltage power for a single operation. Attempts to reduce the high single-phase demands that unbalance the system have resulted in the frequency converter and d-c welders, which largely avoid reactive effects of the secondary circuit and have a balanced three-phase input

FRANK CHARITY, *Consulting Engineer*

DISTRIBUTION problems as well as welding requirements caused Consolidated Vultee Aircraft Corporation to modernize its welding department by addition of three-phase spot welding machines. This was necessary because of the more rigid military specifications for aircraft structural welding, and demands placed on the plant power supply by single-phase machines.

Three-phase machines were chosen to balance the load on substations and feeders. The rectifier type, using d-c welding current, was selected because of better power factor (about 95 per cent as compared with 85 per cent on frequency converter systems and 10 to 30 per cent on single-phase 60 c welders) and the excellent welding characteristics of d-c current for machines with large throat dimensions.

The department will include 13 machines of various types to handle the widely diversified jobs met in aircraft production. Two are older machines to be used for tacking only, since they are not qualified for Class A welding specifications. Another is a two gun single-phase portable unit with a "poke" gun attachment for tacking or assembling specialized steel parts.

The other 10 machines are the new d-c welders mentioned above. These include three 100 kva and one 200 kva press type, four 100 kva rocker arm and one 100 and one 200 kva seam welders capable of meeting aircraft welding specifications. Equal thicknesses of aluminum up to 0.125 in. can be seam welded, those up to 0.188 in. may be spot welded. In stainless steel, maximum thicknesses on the 200 kva machines are 0.140 in. for seam, and 0.235 in. for spot welds on sheets.

An analysis of installation costs for both single- and three-phase welders must include the extra expense if a heavier distribution system is necessary to handle the short surges typical of spot welders. Peak demand may be several times the welder rating (particularly true on deep throat machines) and the pulsation frequency may be such that only one or two volts variation caused by welder loads can be tolerated on lighting circuits.

At a 36 in. throat depth, a conventional single-phase, a-c machine has a kva demand of about 3.6 times the demand of a three-phase rectifier type machine of identical size when each is producing rated secondary current for welding purposes. Demand per phase is about 5.8 times greater for the single-phase welder. As voltage regula-

tion (on the welder supply circuits) is limited to only 5 per cent to meet the requirements of Air Force and Naval Aeronautical resistance welding specifications, a much larger and more expensive power distribution system would have been necessary to supply single-phase machines.

It is estimated that for single-phase welders, substation capacity would have to be increased by 200 kva at an installed additional cost of $5500. Labor and materials for larger wire and conduit, plus increased switchboard capacity, would be about $2800.

The additional costs could have been largely offset by lower initial expenditures and lower maintenance costs for the simpler single-phase machines, but to eliminate objectionable light flicker, it would also have been necessary to increase the capacity of the 2400 v distribution system. Not only would the latter modification cost have been prohibitive, but several days of factory production time would have been lost.

R. D. Leonard, electrical engineer, is responsible for the new Convair welding setup.

In conjunction with the installation of this equipment, a refrigerated, recirculating cooling water system is being built. This will save as much as 125 gpm of Southern California's limited water supply. It will also materially decrease electrode pickup and cleaning time in welding aluminum.

For greater flexibility of operation and simplified maintenance, identical controls for all 10 machines have been specified, except for the ratings of the ignitrons. The transformer-rectifier power packs are also identical, being built up of the required number of standard three-phase, 50 kva units.

Control of the new machines is typical of aircraft type welders, aside from the fact that the weld current is fed into a magnesium-copper-sulfide dry disc three-phase rectifier on the secondary side of the welding transformer. Heat control is accomplished by an 8 tap selector switch on each 50 kva transformer.

There is also an adapter for putting the transformers in series or parallel and connecting them in delta or wye. This arrangement gives an abundance of settings without potentiometer adjustments, so that the settings can be exactly duplicated each time the equipment is used.

Welding sequence controls regulate squeeze, hold, forge delay, post heat, chill, temper and off times. Weld time is controlled through increments of one cycle (60 cps) from .019 to 9.728 sec by toggle switches controlling series resisters in an RS delay circuit. The post heat timer operates in a similar manner, insuring duplication of settings. Other timing circuits are controlled by potentiometer adjustments. Timing impulses are supplied by a 1000 cps relaxation oscillator.

The dual pressure mechanism includes (in addition to the main cylinder) two air cylinders of different sizes, the smaller one "bucking" the larger. When squeeze time starts, both cylinders are filled and the net force is the difference between the two. At the end of forge delay time, the smaller cylinder is "dumped" through a solenoid valve and electrode force is raised to the full amount developed by the larger cylinder. The dual pressure system is used for welding aluminum to reduce weld metal expulsion and cracking. Single pressure can be used, if desired, for welding other metals. Both air cylinders are of the diaphragm type, eliminating the variable friction of conventional pistons.

Weld current to the transformer primaries is controlled by an ignitron contactor fired by thyratrons. The contactor consists of two ignitrons connected in inverse parallel or "back to back" so that each tube passes one-half of the 60 c wave. Two phases of the three-phase line are controlled in this manner. The third phase is fed directly to the transformer primary. The thyratrons are controlled by a synchronous timer so that weld current is always started at the proper point of the primary current wave to eliminate transients.

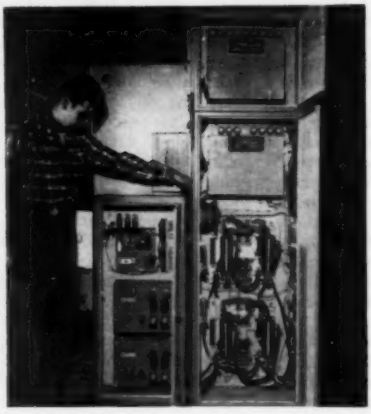
The high thermal conductivity of aluminum may cause a weld to cool rapidly, contributing to high internal stresses and cracks. At the end of the weld period, another current pulse, usually lower, heats the weld and allows it to cool more slowly. This is initiated much the same as weld current by the sequence timer, except that a phase-shift heat control, similar to that on standard single-phase machines, is used. Range is 20 to 100 per cent of full weld current.

Slope control to regulate rate of weld current is not used because the d-c machine has an inherently slow rate of rise due to inductance of the welding circuit.

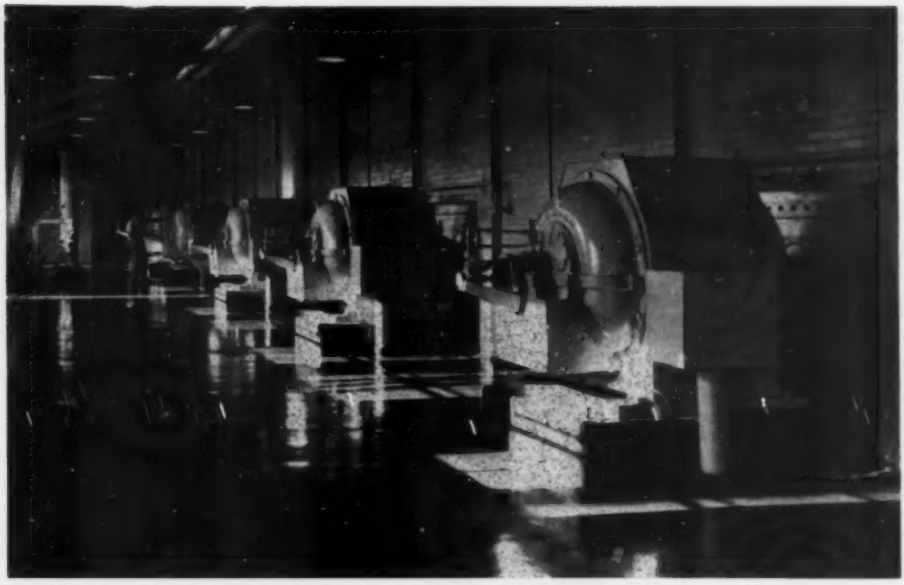
An additional feature is a chill and temper timer for steel welding to reduce weld brittleness and improve fatigue resistance. By means of the sequence controls, steel is welded, allowed to cool for a preset period and then tempered by a lesser weld current pulse controlled by the phase-shift network.

A two-trace, direct writing oscillograph, together with necessary amplifiers, is used to check and adjust spot-weld equipment. Each machine has a calibrated shunt for weld current on the lower electrode. Electrode force is recorded from a strain gage.

Left—Transformer-rectifier units are designed in 50 kva sizes, combined as necessary to provide total power required. Ability to interchange the units simplifies maintenance, repair



Right—Three-phase controls use these two single-phase ignitron contactors, one in each of two lines. Third line is connected directly to transformer



Motor driven centrifugal compressor units are stationed along the line to maintain gas pressure

SERVICE AND OPERATION AT TEXAS EASTERN

Handling natural gas through 4000 mile of pipeline calls for constant attention of booster pumps, compressors and auxiliary equipment. Operational crews are assigned to sections, and they are responsible for service and operation of this vast system

TEXAS EASTERN's pipeline maintenance program is so planned that in case of a major project or emergency, adequate equipment and competent personnel will be near enough to any location. Repairs and changes can be made in the shortest possible time and yet manpower be so dispersed as to maintain the system in the most economical manner. Flexibility of methods and mobility of equipment are of prime importance. Other important considerations are the miles of pipeline, miles of right-of-way and the terrain of country traversed.

Over 4000 mile of pipeline, which cross swamps, plains, mountains and more than 50 major rivers, represent Texas Eastern's widespread maintenance area. The company's main transmission lines, a 20 and 24 in. pipe, originate in Texas and extend north and east through Louisiana, Arkansas, Missouri, Illinois, Indiana, Ohio, West Virginia, Pennsylvania and terminate in eastern New Jersey. A new 30 in. main line is nearing completion. Another line nearing completion extends 791 mile from Kosciusko, Mississippi northeast through Alabama, Tennessee, Kentucky, West Virginia and ties in with the 20 in. and 24 in. lines in western Pennsylvania.

Each type of terrain presents different problems requiring special methods and equipment. In some southern areas, much right-of-way is through rice farms or swamp lands, which make access to the right-of-way almost impossible during summer months. In other sections, there are heavily wooded areas where there are few good roads and even fewer bridges over which heavily loaded trucks or heavy equipment can be moved. In the northern areas the lines pass through sections where coal strip mines are numerous and a constant program of line locations must be carried on in cooperation with strip mine operations to protect the pipelines against possible damage. Sub-surface coal mining in mountainous areas requires constant cooperation from settling and placing undue strains on the pipelines.

A constant watch is maintained on the pipelines by patrol planes, which fly the system at regular intervals. When a maintenance or repair problem is observed from the air, radio contact is made with the crew or foreman in that area and an immediate investigation is made. If the patrol pilot cannot contact a radio unit, a note is dropped at the nearest compressor station, and the information is relayed to the division office that maintains close contact with all maintenance crews.

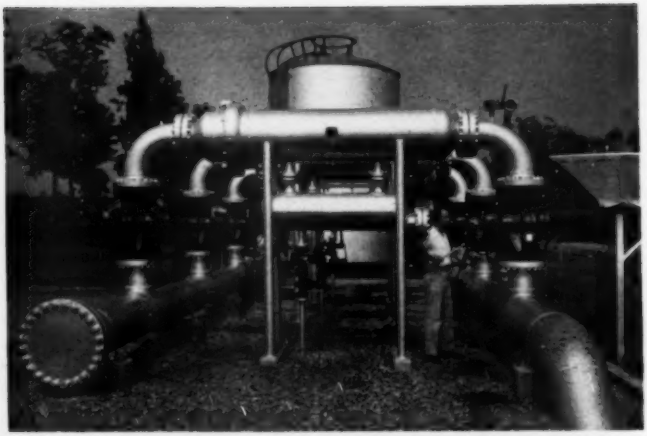
Five operating divisions, each headed by a division manager, control the field operations of Texas Eastern. For maintenance purposes, these five divisions are sub-divided into sections with a foreman in charge of each. A total of 11 foremen supervise Texas Eastern's entire system of 4272 mile of operating pipelines and 2906 mile of right-

of-way. Each foreman has two or more crews under his jurisdiction.

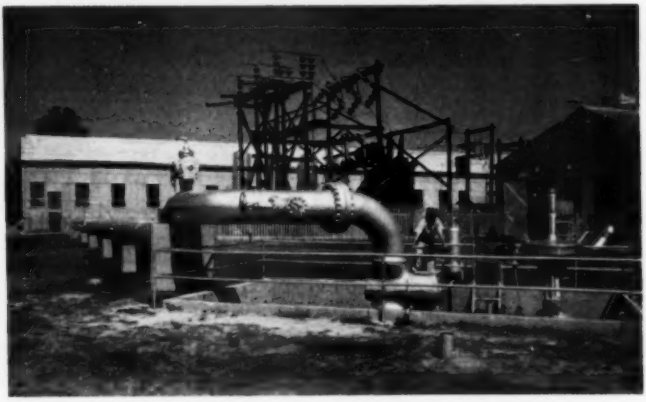
No rule of thumb method was used to determine the amount of right-of-way assigned to each foreman, although there is one crew, approximately, for every 100 mile. A number of factors other than mileages were considered in designating maintenance areas—terrain of right-of-way, number of purchase or delivery points, number of operating stations and accessibility of the pipeline from existing roads and highways.

Maintenance foremen for Texas Eastern have complex and exacting responsibilities. These range from the unexciting job of right-of-way clearing to the more interesting tasks of re-arranging station yard piping and general pipeline construction. New programs of highway repair and construction have made it necessary for pipeline companies to lower and case many of their lines. On Texas Eastern's pipelines, all casing and lowering requirements are fulfilled by maintenance crews. Any work on a line under pressure is performed by Texas Eastern welders and crews. Line taps are often required for purchase or sales points, additional valve installations, crossovers and blowoffs.

Texas Eastern maintenance crews perform minor construction jobs such as re-arranging station yard piping, relocating small lateral lines and removal of small lines. Crews devote some time to internal cleaning of the lines, which is accomplished by running scrapers in the gas stream. When erosion prevention on rights-of-way becomes necessary, the farmer concerned is contacted, and the crews follow his wishes in terrace design and type of cover to be planted. Foremen and crew foremen are the conduct men in their good neighbor policy.



Special attention is given to lubricating valves that service the horizontal gas scrubbers. Equipment is kept in excellent operating condition at all times



Electrical power is purchased to operate the motor driven centrifugal compressors in this station. Piping in foreground leads to gas suction header

The Cover — Natural Gas Compressors

This color illustration shows a portion of the interior of one of Texas Eastern Transmission Corporation's natural gas compressor stations.

Modern compressors of the types used by Texas Eastern make possible transmission of natural gas under high pressure through thousands of miles of big-diameter pipelines. Batteries of compressors in stations located at specified intervals along the pipelines "pull" the gas by suction and discharge it under high compression with sufficient pressure to make it travel in designated volume to the next station or delivery point.

Along Texas Eastern's 3477 mile of pipelines there are 16 centrifugal compressor stations and 10 reciprocating stations with combined installed horsepower totaling 277,650. The illustration shows centrifugal compressors, which are electric motor driven. Audrey Thompson, operator-oiler at Station C, Newton, Tex., tends the center compressor unit as it compresses and speeds gas on to the next unit line, at right, but not shown.

Instrument boards in recess at left, contain meters indicating suction, discharge, seal oil, bearing oil and case pressures. Small lines going to instrument boards and oil tanks in the pits at left are oil, gage and water lines. Water is used in cooling oil circulating units.

On the opposite side of the brick wall, background, are the large electric motors, which drive the centrifugal compressors. Texas Eastern was a pioneer in adapting this efficient type of compressor for gas transmission.

SPECIAL
REPORT
TO INDUSTRY
INDUSTRY AND POWER

COMBATING CORROSION FROM INDUSTRIAL CHEMICALS

INDUSTRY AND POWER is pleased to present to industry this special report on combating corrosion. These data, charts and tables will aid the engineer, responsible for the engineered plant services, in selecting the proper material to handle industrial chemicals for processing and water treatment.

Every year corrosion costs the American industry an average of 4 billion dollars. Some estimates run from as low as 2.5 billion, while others give a high of 8 billion. Enormity of this loss may be better realized when we consider that no single company in the world has an equivalent income. This loss of money is so large that the engineer would do well to expand the old adage and say that there are three things sure in this world—death, taxes and corrosion.

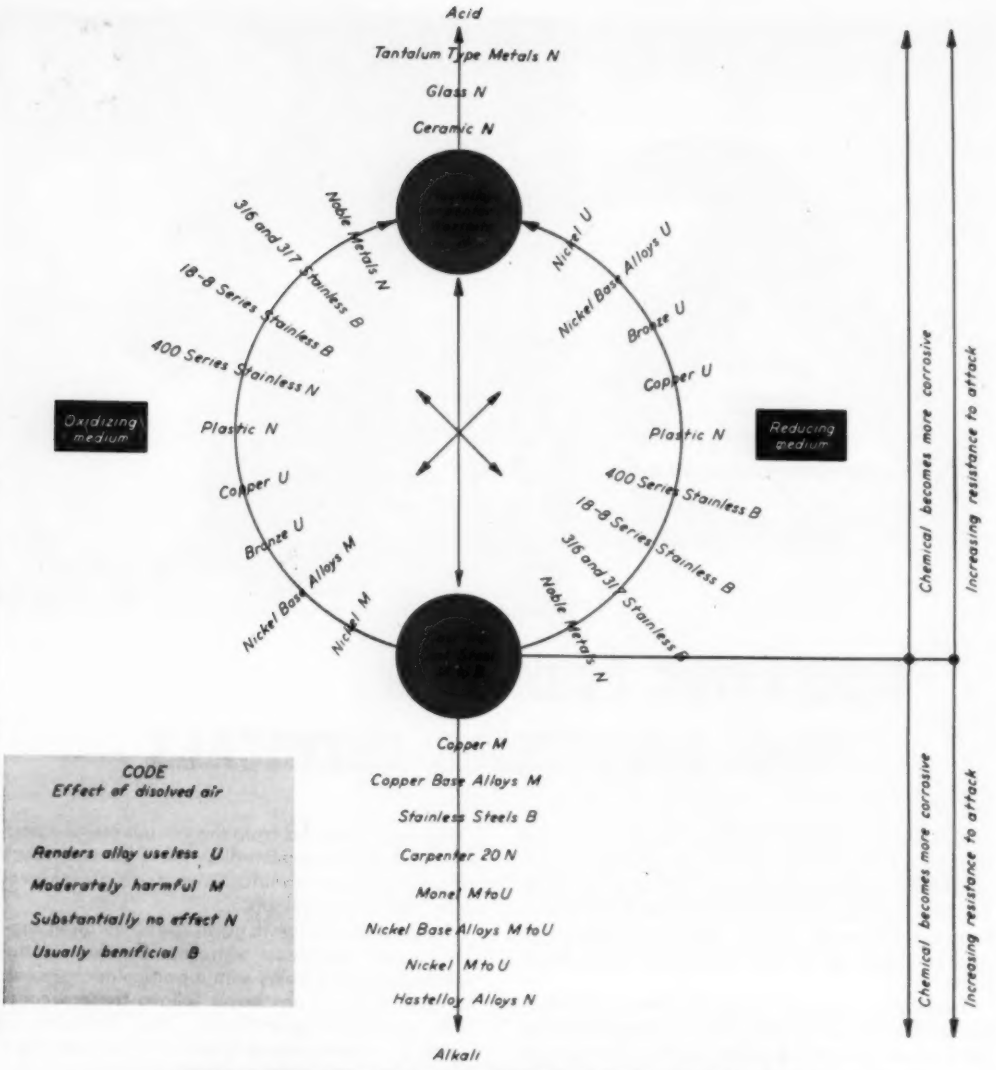
Data in this article are not supposed to be a cure-all, as in some cases corrosion cannot be eliminated. However, following the suggestions in the text, charts and tables will be a step in the right direction towards greatly reducing this problem.

Information in this article is based on considerable research into the field of metals and studying the effect of industrial chemicals upon each. Data were obtained from the various metal manufacturers and augmented by the vast experience of several pump manufacturers dealing exclusively in handling chemicals.

Pump manufacturers go to great detail in supplying their customers with specifications in the exact metals to employ with a particular chemical. In most instances the buyer follows these suggestions, but only in regard to the pump. Obviously, to install a complete piping system with the same type of metal as in the pump might be prohibitive. These charts will prove invaluable for determining a less expensive substitute.

In compiling these charts, the more conservative information was recorded when there were conflicting data. In all, 87 chemicals are listed and their effects upon 26 metals and materials are shown. In some instances the trade name of the metal is employed, but other companies refine the same metal under a different name. The chart notes and tables at the end of this report will aid the engineer in analyzing the numerous variations that might occur in his particular problem. Studying these variables will suggest the selection.

The Editors



MATERIAL REFERENCE CHART

When no concrete corrosion data are available this material reference chart will indicate suitable metals to employ. It will be helpful in choosing a starting point. However, the following facts must be observed in making selections:

1. Solutions become more corrosive going away from cast iron and cast steel.

2. Materials enclosed by small circles must be tested for each application. They are sometimes resistant to oxidation and sometimes reduction.

3. Letters along side the various materials indicate the general effect of dissolved air on the alloy.

4. When slurries are handled, hard materials are required where velocities are high.

5. When salts are handled, select materials depending on the most important radical. In general, salts are less corrosive than their acid radical and more corrosive than their metallic (alkaline) radical.

6. In general, solutions become more corrosive as concentrations and/or temperature increase.

(a) Completely saturated solutions are usually less severe than slightly diluted solutions. Therefore, slurries are usually slightly less corrosive than concentrated solutions of the same chemical.

7. Arrows in the center of the diagram indicate that the same material will be found on opposite sides of oxidation reduction circle.

(a) Cast iron and cast steel are resistant to many powerful oxidizing agents.

(1) Concentrated sulfuric, nitric and chromic acids.

Combating corrosion from industrial chemicals

GEORGE SHAFFER, Chemical Engineer, Milton Roy Co.

CORROSION, in many cases can be completely eliminated, but the cost would be prohibitive. Therefore, the problem is to balance the cost of corrosive attack against the cost of corrosion resistance, prevention and inhibition.

By far the most important raw material is water, which may contain mud, bacteria, large amounts of dissolved oxygen, gases, salts, acids, alkalis and other materials detrimental to plant operation. In general, water is considered non-corrosive or reasonably so. However, during the process of converting water to steam, trace amounts of dissolved or suspended material in the original feedwater are built up to comparatively high concentrations and corrosion may result. Water treatment, by physical and chemical means, will either prevent or greatly inhibit this corrosion. This article will discuss the corrosion resistance of common materials of construction used in accessory equipment, which handles water treating chemicals. In all possible cases, limiting temperatures and concentrations will be specified for various materials of construction. In many instances, completely resistant materials may be obtained, but these will not be considered if they are very expensive or are too difficult to obtain.

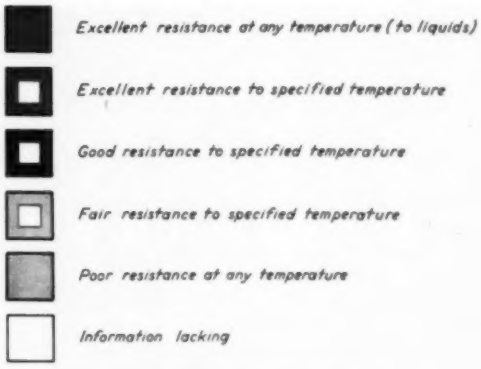
Boilers and accessories are usually made of iron and steel. These materials have little resistance to corrosive attack, but are used primarily because they are inexpensive, readily available, and easily fabricated. Boilers could be made of Carpenter No. 20 stainless steel or the Hastelloys, but the expense would stop the project before it was ever started. Since the common materials of construction have a narrow range of corrosion resistance, the best thing to do is to limit the known corrosion to a negligible degree by proper water treatment. The exact method of water treatment will be special in each case and is better recommended by people who have made a study of this problem.

When the corrosion problem is defined, and the solution determined, the plant engineer decides what materials of construction will be used for fabricating the small controlled volume pumps, tanks, chemical feed lines, valves and fittings used in handling the water treatment chemicals. Buying the least expensive materials of construction that will give adequate protection is common. However, where periodic maintenance shutdowns must be widely spaced, a wiser policy is to take advantage of the greater corrosion resistance of the more expensive materials of construction. For example, when sodium pyrophosphate, sodium tri-polyphosphate or sodium polyphosphate is prescribed as the boiler treating chemical; two alternatives are available. If funds are limited, no hesitation should be made in purchasing controlled volume pumps and accessories in plain iron or steel construction to resist the attack of these chemicals.

Iron and steel give excellent service per dollar for these corrosives but still leave something to be desired where shut-down periods must be widely spaced. When funds are available or breakdown would prove too costly, 18-8 or higher alloy stainless steels should be used in equipment for handling these corrosives.

Large pieces of auxiliary equipment used with boilers are also subject to corrosive attack and are no less important than the boiler. Wooden cooling towers need protection from algae, concrete races and settling basins need protection from acids and algae. Water softeners, deaerating heaters and other equipment also need special protection. Chemicals employed in protection of auxiliary equipment in many instances require more specialized handling than the chemicals used in boiler protection. Boilers and auxiliary equipment handle dilute solutions measured in ppm, while accessory equipment (metering pumps and tanks) handle high concentrations of chemicals, and corrosion resistance

COLOR AND LETTER CODES


Excellent resistance at any temperature (to liquids)
Excellent resistance to specified temperature
Good resistance to specified temperature
Fair resistance to specified temperature
Poor resistance at any temperature
Information lacking
B — To boiling point at atmospheric pressure
H — Hot (to 160°F)
W — Warm (to 120 F)
R — Room temperature (to 75 F)
? — See notes

In all cases the highest color code is used with its corresponding letter code. As a general rule for each higher "letter code" drop one in the color code. For example, if the full code reads, "Excellent at room temperature" (red border enclosing the letter R), then it may be assumed that the resistance will be good at 120 F, (black border enclosing the letter W). Under no circumstance go beyond one step when extrapolating between present data

is their only means of protection.

First consideration in selecting proper materials of construction is to determine the nature of the corrosive medium to be handled. Corrosive media may be divided into three main classes: acids, alkalis and salts. Under each class the nature of the attack must be considered as to whether it is oxidizing, reducing, ionic or, if there is no attack, whether the material will catalyze a chemical reaction in the solution. Other factors, which will affect the corrosiveness of the chemical, will be the quality and quantity of dissolved gases, temperature, fluid velocity, abrasiveness, galvanic action and impurities.

Under normal circumstances, an increase in any one factor, would be expected to have an adverse effect on the corrosiveness of the solution. However, there are many instances where an increase in one or more factor is helpful and, in some cases, desirable. For example, 316 stainless steel pipe lines and pumps can handle 5 per cent solutions of alkaline sodium hypochlorite and show excellent life [1]. However, when the same solution is allowed to stand in a 316 stainless steel tank or stagnate in lines where there is little or no agitation, the tank or lines will become badly pitted (particularly at the liquid level line) and useless in a matter of weeks. For a second example, aeration of most solutions being handled is normally desirable against any of the stainless steels but usually renders copper and copper based alloys useless [2], [3].

Once the nature of the solution being handled is determined, then choice of construction materials can be made. Order of procedure for this operation is as follows:

1. Past personal experience on similar equipment is the best criteria.
2. Known reliable corrosion data.
   a) These data are usually broad in nature and only offer excellent recommendations of materials for further consideration on specific installations.
   b) In many instances published corrosion data are based on laboratory tests with pure chemicals at controlled conditions and therefore are slightly optimistic. However, unless actual conditions are exceedingly severe these data are usually reliable.
   c) Some data have been compiled throughout this article and in all possible cases the recommendations given are modified by experience.
3. No known data or unreliable data.
   a) In this situation starting from scratch is necessary.

		Cast Iron	Cast Steel	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Carpenter No. 20	Nickel	Monel	Hastelloy "B"	Hastelloy "C"	Hastelloy "D"	Plastic (Plexiglas)	
Activated Carbon	Slurry	R	R												1
Aluminum Sulfate	All			H	H	H	H		?	?	H			W	2
Ammonia (Dry)	Liquid	W	W	H	H	H	W		R	R					3
Ammonium Alum	All			W	W	H	W		R	R	H		H	W	4
Ammonium Hydroxide	All	W	W	H	H	H	W		?	?				W	5
Ammonium Sulfate	<10%	?	?	H	B	B			W	W	B			W	6
Ammonium Sulfate	>10%			R	R	R			?	?	H			W	7
Bentonite	Slurry														8
Bromine (Dry)	Liquid	R	R	R	R	R	R	R	R	R					9
Bromine (Wet)	Liquid											R			10
Bromine Water	Dilute			R	R	R		R						W	11
Calcium Hydroxide	Slurry	H	H	H	H	H	H	H	H	H	H	H	H	R	12
Calcium Hypochlorite	>2%	R		?	?	?		W	?	?		W		W	13
Calcium Hypochlorite	<2%	R		?	?	?		R				R		W	14

Only four compounds will be considered in the corrosion by alkalis group since these are the four most common to water treatment work. These are ammonium hydroxide, calcium hydroxide, magnesium hydroxide and sodium hydroxide (potassium hydroxide although rarely used may be considered in the same category as sodium hydroxide). In general, the alkalies are considered easy to handle, and cast iron or cast steel construction is normally considered for concentrations below 20 per cent for any of these compounds. In concentrations to 85 per cent or at temperatures to 500 -600 F, nickel and Monel are normally regarded as the best possibility. Glass and stoneware are usually not considered as materials of construction.

Ammonium Hydroxide

At solution temperatures around 70 F, cast iron or cast steel offer the best choice as materials of construction to resist the attack of ammonium hydroxide. At temperatures above 150 F, their ability to withstand the attack of ammonium hydroxide falls off considerably. Contrary to expectation, nickel and Monel are not to be used.

Although nickel and Monel will resist attack of ammonium hydroxide, provided the solution is air free, only small traces of air are necessary to render either alloy questionable [4]. In the presence of air, both nickel and Monel are fairly satisfactory at low or at very high concentrations, but in concentrations between 3 to 25 per cent, rate of attack builds up very sharply and reaches a maximum at about 12 to 15 per cent. No copper or high copper alloy should be considered for use against this corrosive. If temperatures above 160 F are to be encountered, Carpenter No. 20 stainless steel or any of the Hastelloys should give excellent service. Glass and ceramics, contrary to expectation, offer satisfactory resistance to ammonium hydroxide attack under most circumstances.

Calcium Hydroxide

Calcium hydroxide is comparatively non-corrosive because of its slight solubility. Any considerable quantity will normally be handled in the slurry form, and abrasion—not corrosion—will be the limiting factor. Iron and steel are completely satisfactory under most conditions. For high slurry velocities, hardened forms of these materials or other hard alloys should be used.

Magnesium Hydroxide

Magnesium hydroxide is slightly less corrosive than calcium hydroxide, and same precautions should be observed.

		Ni-Resist	Haveg	Copper and Amberloy	Everdur	Phosphor Bronze	Commercial Bronze and Red Brass	Porcelain	Glass	Tantalum	Permalite	Rubber	Asbestos	Karbate Impervious Graphite	
Activated Carbon	Slurry														1
Aluminum Sulfate	All	W	B	B	B	R	R					H	H	B	2
Ammonia (Dry)	Liquid	H	W	R	R	R	R	H	H			R	R	B	3
Ammonium Alum	All	W	W	R	R	R	R					W	H	B	4
Ammonium Hydroxide	All	B	W					H	H	R		R	R	B	5
Ammonium Sulfate	<10%	W	B	R	R	R	R					H	H	H	6
Ammonium Sulfate	>10%	W	B	R	R	R	R					H	H	H	7
Bentonite	Slurry		W												8
Bromine (Dry)	Liquid	R		R	R	R	R								9
Bromine (Wet)	Liquid			R	R	R	R								10
Bromine Water	Dilute			R	W	R	R								11
Calcium Hydroxide	Slurry	W	W	H	H	R	R	R	R			W	R	B	12
Calcium Hypochlorite	<2%	R		R	R	R	R	B	B	B	H	W	W	R	13
Calcium Hypochlorite	>2%	R		R	R	R	R	B	B	B	H	W	W	R	14

Sodium Hydroxide

18-8 stainless steel and cast steel, although slightly attacked by sodium hydroxide at most temperatures and concentrations below 50 per cent are limited in scope because of caustic embrittlement [5]. After only little attack, the metal is weakened by a physical change that occurs (within the grain boundaries) at about 180-200 F. Once caustic embrittlement has occurred, only slight mechanical shock is necessary to crack the metal. At high temperatures and concentrations, particularly 70 to 85 per cent and around 600 F, nickel and Monel are the most common materials of construction [6].

Above 85 per cent concentration and 600 F, nickel and Monel are also subject to caustic brittleness [7], and Hastelloys or Carpenter No. 20 stainless steel should be used. Hot concentrated sodium hydroxide is one of two chemicals that will attack Teflon, the other is liquid fluorine. In general, cast iron, 400 series stainless steels and copper alloys resist corrosion by sodium hydroxide no better than 18-8 stainless steel or cast steel but have the advantage of not being subject to caustic embrittlement. Plastics, glass, stoneware and tantalum are not recommended for any service to resist sodium hydroxide.

Corrosion by Acids

Acids most commonly used in water treatment are: sulfuric, phosphoric, hypochlorous (chlorine in water solution), hypobromous (bromine in water solution), chromic and hydrofluoric (considered primarily because it is used for dissolving filter aid from screens). Acids are normally considered the most corrosive of chemicals, and for this reason competent advice should be sought before ordering equipment for handling them. Unlike most chemicals, there are no general rules for corrosion resistance to acids. Each acid must be considered individually.

Sulfuric Acid

Most important acid to the power plant engineer, as well as to industry in general, is sulfuric acid. Cast iron and cast steel are not usually given their just due as materials of construction resistant to sulfuric acid attack. Normally, cast iron or cast steel will be recommended for concentrations between 90 and 100 per cent, and then only at moderate temperatures, that is below 100 F. Resistance of these two metals to sulfuric acid extends beyond these small bounds, and it will pay considerable dividends to check their usage within the limits of 62 to 100 per cent concentration at temperatures

		Cast Iron	Cast Steel	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Carpenter No. 20	Nickel	Monel	Hastelloy "B"	Hastelloy "C"	Hastelloy "D"	Plastic (Plexiglas)	
Calcium Sulfate	All	?	?	?	?	H	?		?	?	H		H	W	15
Chlorine (Dry)	Liquid	?	?	R	R	R	R	H	W	W		W			16
Chlorine (Wet)	Liquid							R				W			17
Chlorine Water	Dilute			R	R	R		R	R	R		W		R	18
Copper Sulfate	All	R	R	B	B	B	H	B	R	R		B		W	19
Copper Sulfate and Sulfuric Acid	All and 10% H_2SO_4			R	R	H		H		R		B		W	20
Ferric Chloride	<10%											H		W	21
Ferric Chloride	<45%											R		W	22
Ferric Sulfate	<10%			R	R	B	R					W		W	23
Ferric Sulfate	>10%			R	R	R	R					W		W	24
Ferrous Sulfate	<10%	R	W	B	B	B	W		W	H	H		H	W	25
Ferrous Sulfate	>10%	R	R	R	R	R	R			?	H		H	W	26
Fluosilicic Acid	<17%			?	?		?	R	W	W	R	W	R	W	27
Fluosilicic Acid	>17%			R	R		R	R	R	R	R	R	R	W	28

up to 140 F and near 95 per cent concentration at temperatures as high as 300 F [8].

When employing cast iron or cast steel against sulfuric acid concentrations between 62 and 80 per cent, it is advisable to give the apparatus a heavy protective coating of ferrous sulfate by allowing 66 deg Baume acid to stand in it for 24 to 48 hr. This is particularly recommended if, in subsequent operation, there is going to be considerable agitation. The more dilute acids will not give the cast iron a chance to build up sufficient protective coating if the solution is agitated but, when the protective coating is built up with the strong acid, violent agitation is necessary to dislodge this coating and render the iron subject to attack by the more dilute acids.

Iron or steel construction should not be used in open vessels exposed to air since the sulfuric acid wetting the sides of the vessel will absorb large quantities of moisture from the air and form a highly diluted and very corrosive sulfuric acid. Because concentrated sulfuric acid is a strong oxidizing agent, even large quantities of dissolved air have no appreciable effect in increasing the corrosiveness of the acid [8].

When necessary to use dissimilar metals for fittings on equipment made of cast steel and cast iron, they should be chosen with caution. At any concentration, violent galvanic corrosion will occur when iron, steel, or stainless steel is in close contact. Hastelloy "C" and "D", ceramics and glass have shown excellent resistance when coupled with cast iron or cast steel. An exception to the "no-stainless-steel" is Carpenter No. 20 stainless steel, which renders quite satisfactory service with little loss due to galvanic action.

The 18-8 series stainless steels show fair resistance to sulfuric acid attack in many ranges. They are usually ignored in the high concentration range because iron and steel are better and less expensive. Throughout any range where they are serviceable, the 18-8 series stainless steels are subject to galvanic corrosion unless the system is monometalic. Carpenter No. 20 stainless steel shows excellent resistance to sulfuric acid attack at any concentration to 150 F. Below 20 per cent concentration, it shows excellent resistance to the boiling point.

Hastelloys show excellent resistance to sulfuric acid attack over any range of concentration. Hastelloys "B" and "D" are normally preferred. Below 10 per cent concentration, they are quite liable to corrosion attack, and Hastelloy "C" is preferred in this range. Between 75 and 95 per cent, none of the

		Ni-Resist	Haveg	Copper and Amberloy	Everdur	Phosphor Bronze	Commercial Bronze and Red Brass	Porcelain	Glass	Tantalum	Permolite	Rubber	Asbestos	Karbate Impervious Graphite	
Calcium Sulfate	All	H	H	R	R	R	R					H	H	B	15
Chlorine (Dry)	Liquid		W	W	W	W	W						R	H	16
Chlorine (Wet)	Liquid		R									R		H	17
Chlorine Water	Dilute		R	R	H	R	R					R	R	H	18
Copper Sulfate	All		H	R	R	R	R					H	R	H	19
Copper Sulfate and 10% Sulfuric Acid	All and 10% H_2SO_4		H	R	R							H	R	H	20
Ferric Chloride	<10%		H	R								H	R	H	21
Ferric Chloride	<45%		H									H	R	H	22
Ferric Sulfate	<10%		W					B	B			H	R	B	23
Ferric Sulfate	>10%		W					B	B			H	R	R	24
Ferrous Sulfate	<10%		W	B	B	B	B	B	B			B	H	B	25
Ferrous Sulfate	>10%		W	W	W	W	W	B	B			B	R	W	26
Fluosilicic Acid	<17%	H	W	R	H	R	R	?	?			H		H	27
Fluosilicic Acid	>17%	R	W	R	H	R	R	?	?			H		H	28

Hastelloys are recommended at temperatures above 160 F [10]. High silicon iron, such as Duriron, is the most resistant metal to sulfuric acid attack over any concentration range at any temperature. Porcelain, glass, tantalum and resinous coatings are recommended for use wherever and whenever possible.

For concentrations below 20 per cent, plastics such as Plexiglass or Lucite have almost complete resistance to attack by sulfuric acid. Addition of air to sulfuric acid improves the corrosion resistance of Ni-resist, while dissolved air reduces the resistance of copper and copper alloys to sulfuric acid attack to zero [11]. Even in the case of Monel, which shows excellent corrosion resistance up to 200 F at sulfuric acid concentrations as high as 80 per cent, dissolved air renders Monel only fairly corrosion resistant at room temperatures.

Corrosion tests of gray cast iron in fuming sulfuric acid are misleading since they will indicate excellent resistance. However, gray cast iron should not be used for handling this corrosive since there is marked tendency to absorb the sulfuric acid [12]. Slow rates of corrosion inside the pores of a casting (interstitial corrosion) will cause violent explosions when the trapped hydrogen builds up pressure after prolonged attack.

Phosphoric Acid

Phosphoric acid in general is not as corrosive as sulfuric. However, at phosphoric acid concentrations above 114 per cent (approximately 86 per cent P_2O_5) and temperatures above 300 F [13], no metal is resistant to attack. The Hastelloys, particularly Hastelloy "C", have fair resistance against this corrosive at temperatures up to 150 F.

In many cases, the common impurities in phosphoric acid (hydrofluoric and fluosilicic acids) may determine the alloy to use. In general, air will increase the rate of attack for any concentration range of phosphoric acid. However, aeration of phosphoric acid is necessary for good corrosion resistance with stainless steels [14]. While copper base alloys offer good resistance to phosphoric acid attack, they are useless if the acid is aerated [14]. Small additions of arsenic compounds to

		Cast Iron	Cast Steel	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Carpenter No. 20	Nickel	Monel	Hastelloy "B"	Hastelloy "C"	Hastelloy "D"	Plastic (Plexiglas)	
Hydrofluoric Acid	<50%								R	R	R	H	R	W	29
Hydrofluoric Acid	Anhydrous		H						R	R	R	H	R	W	30
Magnesium Oxide	Slurry													R	31
Potassium Alum	<10%		R	R	R	B	R	?	R	W	B	B	B	W	32
Potassium Alum	>10%		R	R	R	W	R	?	R	R	W	H	W	W	33
Silicic Acid	Slurry			H	H	H	W		H	H				W	34
Sodium Aluminate	All	R	R	B	B		R							W	35
Sodium Bi-Sulfite	<25%	R	R	B	B	B	R		R	H	B		B	W	36
Sodium Bi-Sulfite	<50%			H	H	B	R		R		W		H	W	37
Sodium Carbonate	All	W	W	B	B	B	H		B	B				W	38
Sodium Chloride	<30%	?	?	?	?	R	?		H	H				W	39
Sodium Chloride	Saturated	?	?	?	?	B	R		H	B				W	40
Sodium Chlorite	All											W			41
Sodium Fluoride	All	R	R	R	R	H	R		H	H	H	H	H	W	42
Sodium Fluosilicate	All	R	R	W	W	W	R		H	H	H	H	H	W	43

dilute phosphoric acid will greatly decrease the rate of attack and permit the use of steel [18b].

Although phosphoric acid will absorb moisture from the air, it is not necessary to take special precautions in choosing the materials for handling this acid in open containers. As a general rule, phosphoric acid becomes more corrosive as the concentration increases.

Chromic Acid

Chromic acid is a powerful oxidizing agent, and it is highly corrosive for this reason. If sulfuric acid is an impurity in chromic acid, the corrosion rate is increased. Small additions of alkalis will inhibit this attack. Cast iron is satisfactory for handling chromic acid solutions provided there is no free sulfuric acid present [18b]. In general, high copper alloys are not satisfactory.

Although the 18-8 series of stainless steels give excellent resistance over a wide concentration range of chromic acid, they are not recommended because of pitting attack. Carpenter No. 20 stainless steel is satisfactory for all chromic acid concentrations at temperatures below 100 F. Of the Hastelloys, only Hastelloy "C" is recommended for chromic acid service.

Hypobromous Acid (Bromine Water)

The copper base alloys and Hastelloy "C" resist the attack of bromine water quite well. Certain plastics and glass, ceramics and tantalum are excellent. For concentrations below 1 per cent, 18-8 stainless steels offer fair resistance for short periods of time.

Hypochlorous Acid (Chlorine Water)

Chlorine water is generally more corrosive than bromine water, but normally the same materials of construction will give excellent resistance. However, nickel and Monel are more corrosion resistant to chlorine water while copper base alloys are not recommended.

Hydrofluoric Acid

Above concentrations of 60 per cent, cast iron is quite satisfactory as a material of construction for handling hydrofluoric acid. However, care must be taken to see that dilution does not

		Ni-Resist	Haveg	Copper and Amberloy	Everdur	Phosphor Bronze	Commerical Bronze and Red Brass	Porcelain	Glass	Tantalum	Permalite	Rubber	Asbestos	Karbate Impervious Graphite	
Hydrofluoric Acid	<50%	R	B	H	R	H	H			H		W		B	29
Hydrofluoric Acid	Anhydrous	H	B	B	R	H				H					30
Magnesium Oxide	Slurry	B	W	W	W	W	W	B	B	B		B	R	B	31
Potassium Alum	<10%	R	R	W	W	W	W	B	B			W	?	H	32
Potassium Alum	>10%	R	R	R	R	R	R	B	B			W	?	H	33
Silicic Acid	Slurry							H	H						34
Sodium Aluminate	All	R	W	R	R	R	R					R	R	R	35
Sodium Bisulfite	<25%		W	R	R	R	R					H		B	36
Sodium Bisulfite	<50%		W	R	R	R	R					H		R	37
Sodium Carbonate	All	H	R	R	R	R	R	H	H	H		H	H	H	38
Sodium Chloride	Dilute	W	W	R	R	?	R	B	B			H	H	H	39
Sodium Chloride	Saturated	H	W	R	R	?	R	B	B			H	H	H	40
Sodium Chloride	All	R	R	R	R	R	R	H	H						41
Sodium Fluoride	All	R	R		R			B	B			H			42
Sodium Fluosilicate	All	R	W	H	H	R	R	B	B			R	R		43

occur on the walls of a vessel holding the acid since the dilute acid is very corrosive. Stainless steels are not recommended for handling this corrosive while copper base alloys, in general, offer fair resistance to any concentration range. Nickel, Monel and Hastelloy alloys offer some of the best all around protection against hydrofluoric acid.

In handling salts, it is quite often necessary to base materials of construction on the impurity rather than on the salt that constitutes the main body of the chemical. This is the case because salts are usually difficult and expensive to obtain in the pure state, and often only traces of impurities are necessary to change the corrosion picture. However, there are a few general rules that may be followed. All Halogen acid salts should be given special consideration, particularly the chlorides. These salts, whether neutral or in the presence of a slight excess of alkali, are very corrosive materials.

In general, neutral or alkaline salts are only mildly corrosive. Oxidizing and reducing salts are normally quite corrosive, and this action is only slightly inhibited when they are neutral or alkaline and considerably increased when acid. All acid salts are corrosive and should be treated with caution. In the following paragraphs only the most important salts, grouped according to their acid radical, will be discussed.

Phosphates

One of the most common families of boiler treating chemicals is the phosphates. The most corrosive of the common phosphates is monosodium phosphate. This is an acid phosphate and can be handled successfully in any concentration with type 316 stainless steel. Di-sodium and tri-sodium phosphates are the least corrosive of the common phosphates and are handled quite readily with cast iron or cast steel construction. Materials for handling meta or poly-phosphates should be chosen carefully, particularly pyro, tripoly, and tetrapoly phosphates.

Sodium pyrophosphate, tripolyphosphate, and sodium tetrapolyphosphate may all be handled successfully with cast iron and cast steel construction. However, critical pieces of equipment, where long trouble free service is mandatory, should be fabricated from 18-8 stainless steel or higher alloy. In the case of the tripoly and tetrapoly phosphates, small additions of sodium hy-

		Cast Iron	Cast Steel	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Carpenter No. 20	Nickel	Monel	Hastelloy "B"	Hastelloy "C"	Hastelloy "D"	Plastic (Plexiglas)	
Sodium Silicate	All	W	W	H	H	H	W		H	H	H	H	H	W	44
Sodium Sulfite	All	?	?	H	H	B	R		H	H				W	45
Sodium Thiosulfate	<25%	R	R	B	B	B	W		B	B	H		H	W	46
Sodium Thiosulfate	>25%			R	R	R	R		B	B	H		H	W	47
Sodium Hydroxide	<20%	H	H	B	B	B	R							R	48
Sodium Hydroxide	20-30%	W	H	H	H	H	R								49
Sodium Hydroxide	30-50%	W	W	H	H	H									50
Sodium Hydroxide	50-70%	H	H					H							51
Sodium Hydroxide	70-80%							H							52
Sodium Hydroxide	80-85%														53
Sodium Hydroxide	Molten														54
Phosphoric Acid	0-5%		R	B	B	B	?	B	W	H	B	B	B	R	55
Phosphoric Acid	5-10%		R		B	B	?	B	W	H	B	B	B	R	56
Phosphoric Acid	10-25%		R	B	B	B	?	B	W	H	B	B	B	R	57
Phosphoric Acid	25-50%			B	B	B	?	B	R	H	B	B	B	R	58

droxide would be beneficial though not necessary. Sodium hexametaphosphate and higher metaphosphates may not be handled in cast iron or cast steel under any circumstances even if excess sodium hydroxide is present. The excess sodium hydroxide will reduce the corrosive action to a measurable extent, but not sufficiently to allow the successful use of cast iron or cast steel for extended periods. 18-8 stainless steel should be used for handling the meta polyphosphates.

Recommendations

As a general rule, the following will be satisfactory. Ratio of sodium atoms in phosphorous atoms in the compound equal to or greater than 2 to 1, cast iron and cast steel should be used without hesitation. When the ratio of sodium atoms to phosphorous atoms in the compound is between 3:2 and 2:1, cast iron and cast steel may be used satisfactorily, and the addition of sodium hydroxide to bring the ratio to 2 to 1 will yield excellent results. If the ratio of sodium atoms to phosphorous atoms in the compound is more than 1 to 1 and less than 3 to 2, 18-8 stainless steel or higher alloy is mandatory—even in the presence of excess sodium hydroxide. With sodium to phosphorous ratio of 1 to 1, then 316 stainless steel or higher alloy is necessary in handling the corrosive. glass and stoneware show excellent resistance to sodium phosphate attack. However, they should not be used at flow control surfaces such as check valves since there is a tendency for mild pitting which will render the control surfaces useless [16].

Sulfites

Corrosive action of sodium sulfite solution will be due more to impurities than to the action of the chemical itself. If the water used to dissolve the sodium sulfite contains any large quantities of air, the chemical will be quite corrosive. Normally, the best practice is to make small additions of sodium hydroxide to the sodium sulfite to maintain the solution non-corrosive. Cast iron and cast steel construction will be quite satisfactory as long as air is excluded from the system.

Hastelloy "A", "B" and "D" and copper base alloys are not recommended for this service for extended periods of time. Glass and stoneware are not recommended because of the alkaline nature of the chemical.

		Ni-Resist	Haveg	Copper and Amberloy	Everdur	Phosphor Bronze	Commercial Bronze and Red Brass	Porcelain	Glass	Tantalum	Permolite	Rubber	Asbestos	Karbate Impervious Graphite	
Sodium Silicate	All	R	W	H	H	H	H	R	R			H	H	H	44
Sodium Sulfite	All	B	?	R	R	R	R					H	R	H	45
Sodium Thiosulfate	<25%		W	R	R	R	R					R	H	H	46
Sodium Thiosulfate	>25%		R									R	H	H	47
Sodium Hydroxide	<20%	H	W	H	H	H	H				H	H	R	B	48
Sodium Hydroxide	20-30%	H		H	H	H	H				H	H	R	H	49
Sodium Hydroxide	30-50%	H		R	W	W	W				H	H	R	H	50
Sodium Hydroxide	50-70%	R		R										H	51
Sodium Hydroxide	70-80%	R												H	52
Sodium Hydroxide	80-85%													H	53
Sodium Hydroxide	Molten														54
Phosphoric Acid	0-5%	R	B	H	H	H	W	B	B	B		H		B	55
Phosphoric Acid	5-10%	R	B	H	H	H	W	B	B	B		H		B	56
Phosphoric Acid	10-25%	R	B	W	W	H	W	H	H	H		H		H	57
Phosphoric Acid	25-50%	R	B	W	W	W	W	H	H	H		H		H	58

In general, the best materials for handling the sulfates are the 18-8 stainless steels. Cast iron, carbon steel, and copper base alloys are not particularly good for this service. Of the Hastelloys, only Hastelloy "C" is generally recommended. For handling copper sulfate, Hastelloy "C" is not recommended. When there is no free acid present, cast iron or carbon steel may be used to a limited extent. Special care should be taken in handling calcium sulfate. Calcium sulfide may be present and will liberate hydrogen sulfide, which is quite corrosive to many materials that would otherwise be excellent.

The chlorides in general are the most corrosive of all chemical salts, particularly to stainless steels [17]. Hastelloy "C" is one of the best all around alloys of construction for handling chlorides. Monel usually shows excellent resistance, and Carpenter No. 20 stainless steel is also quite resistant. Many plastics have excellent resistance to the chlorides and should be considered along with glass and ceramics as materials of construction where high structural strength is not the dominating factor. Ferric chloride (one of the most corrosive chemicals known) is easily handled with Plexiglass or Lucite plastics, ceramics and glass construction.

Hypochlorites are powerful oxidizing agents and, for this reason, are quite corrosive. They should be handled, if possible, in neutral or alkaline solution since an acid solution increases the corrosion rate. Pumps made of 316 stainless steel are fairly satisfactory for handling hypochlorites, but tanks made out of the same material last only a very short time [18]. Even in pumps, if the system is shut down for a long period without being flushed, there is a tendency toward pitting attack. This is one of those unusual circumstances where it is necessary to keep the solution in motion in order to prevent attack. For temporary service, iron or carbon steel may be used, but they offer only mediocre resistance.

Hastelloy "C" offers excellent resistance, while this is one of the few cases where Carpenter No. 20 stainless steel is not as good as 316 stainless steel [19]. Plastics are excellent for handling this corrosive. If the solution is not too alkaline, glass or ceramic construction is also good. However, glass

		Cast Iron	Cast Steel	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Carpenter No. 20	Nickel	Monel	Hastelloy "B"	Hastelloy "C"	Hastelloy "D"	Plastic (Plexiglas)	
Phosphoric Acid	50-70%			R	R	H		H	R	H	B	B	B		59
Phosphoric Acid	70-85%			R	R	H		H	R	W	B	B	B		60
Phosphoric Acid	85-90%					R		H		W	B	B	B		61
Phosphoric Acid	90-100%					R		R		W	B	B	H		62
Pyro Phosphoric Acid	100-114%		W			R		R		R	B	B	H		63
Pyro Phosphoric Acid	114%+														64
Meta Phosphoric															65
Tri-Sodium Phosphate	All	W	W	B	B	B	B	B	B	B			H	?	66
Di-Sodium Phosphate	All	W	W	B	B	B	B	B	B	B			H	?	67
Sodium Pyro-Phosphate	All	R	R	B	B	B	W	B	B	B			H	?	68
Sodium Tri-Phosphate	All	R	R	B	B	B	W	B	B	B			H	?	69
Sodium Tetra-Phosphate	All	R	R	B	B	B	R	B	B	B			H	?	70
Sodium Hexameta-Phos	All			B	B	B		B	W	B			H	?	71
Sodium Heptameta Phos	All			B	B	B		B	W	B			H	?	72
Sodium Octameta-Phos	All			B	B	B		B	W	B			H	?	73

and ceramics, as in the case of phosphates, should not be used at control surfaces because of the slight tendency toward pitting, which will render control surfaces inefficient. Sometimes phosphates and hypochlorites are mixed together and, in these cases, glass and ceramics are particularly poor, although not as poor as against phosphates alone.

Due to the short treatment accorded so broad a subject, certain factors had to be omitted. The most important of these factors is galvanic corrosion. A "rule of thumb" to be followed where dissimilar metals must be used is to choose those metals as close together in the galvanic series as possible. Also, where possible, use the most noble metal for the part having lesser area.

Information given in this article is offered as a guide in the selection of materials of construction for handling water treatment chemicals. It is not intended as the solution to all corrosion problems—there will be specific cases at variance with the data reported. However, these data represent the best available information gathered from many sources and are as nearly as possible the consensus of the recognized authorities on the subject of corrosion.

Final selection of materials for a specific application should always be based upon the advice of a competent supplier of the equipment being considered. To make a good recommendation the supplier should be furnished with information such as: chemical being handled, concentration, temperature, agitation, aeration and impurities.

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(2) Uhlig, "Corrosion Handbook", P 23. McKay & Worthington, "Corrosion Resistance of Metals & Alloys", P 286-290

(3) McKay & Worthington, "Corrosion Resistance of Metals & Alloys", P 410-417

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(5) Nelson, "Corrosion Data Survey", P S-2

(6) Rabald, "Corrosion Guide", P 487

(7) Nelson, "Corrosion Data Survey", P S-2

(8) Rabald, "Corrosion Guide", P 542. Nelson, "Corrosion Data Survey", P S-5. McKay & Worthington, "Corrosion Resistance of Metals & Alloys", P 250-254. Mars G. Fontana, "Industrial & Chemical Engineering", Vol. 43, No. 3, P 71 ., Vol. 43, No. 8, P 65A

		Ni-Resist	Haveg	Copper and Amberloy	Everdur	Phosphor Bronze	Commercial Bronze and Red Brass	Porcelain	Glass	Tantalum	Permolite	Rubber	Asbestos	Karbate Impervious Graphite	
Phosphoric Acid	50-70%	R	H	H	H	W	H	H	H	H		H		H	59
Phosphoric Acid	70-85%	R	H	H	H	W	H	R	H	R				H	60
Phosphoric Acid	85-90%	W	H	R	H		H	R	H					H	61
Phosphoric Acid	90-100%	W	H				R	H						H	62
Pyro Phosphoric Acid	100-114%	R													63
Pyro Phosphoric Acid	114%+														64
Meta Phosphoric Acid	All			H											65
Tri-Sodium Phosphate	All	B	H	B	B	W	B				B	H	H	H	66
Di-Sodium Phosphate	All	B	H	B	B	W	B	H	H		B	H	H	H	67
Sodium Pyrophosphate	All	H	H	B	B	W	H	H	H		B	H	H	H	68
Sodium Tri-Phosphate	All	R	H	B	B	W	H	H	H		B	H	H	H	69
Sodium Tetra Phosphate	All	R	H	R	H	R	R	B	H		B	H	R	H	70
Sodium Hexa Meta Phosphate	All	R	H	R	H	R	R	B	H		B	H	R	H	71
Sodium Hepta Meta Phosphate	All	R	H	R	R	R	R	B	H		B	H	R	H	72
Sodium Octa Meta Phosphate	All	R	H	R	R	R	R	B	H		B	H	R	H	73

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(13)a L. D. Yates, "Chemical Engineering Report No. 9", TVA 1951

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(16) Special tests by Betz Laboratories, Philadelphia, showed rapid erosion of glass ball checks in metering pumps

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		Cast Iron	Cast Steel	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Carpenter No. 20	Nickel	Monel	Hastelloy "B"	Hastelloy "C"	Hastelloy "D"	Plastic (Plexiglas)	
Sodium Decameta-Phos	All			B	B	B		B	W	B			H	?	74
Sodium Meta Phosphate	All			R	R	B		B	W	B			H	?	75
Mono Sodium Phosphate	All			R	R	B		B	W	B			H	?	76
Sulfuric Acid	1-5%			R	R	H	?	B	R	R				W	77
Sulfuric Acid	5-10%			R	R	H	?	B	R	R	W		W	W	78
Sulfuric Acid	10-20%			R	R	W	?	B	R	R				W	79
Sulfuric Acid	20-40%			R	R	R		H	R	R		H		R	80
Sulfuric Acid	40-62%							H	R	R		H			81
Sulfuric Acid	62-75%	R						W	R	R	H	H	H		82
Sulfuric Acid	75-85%	R	R					W		R	H	H	H		83
Sulfuric Acid	85-90%	R	R	R	R	R		H			H	H	H		84
Sulfuric Acid	90-95%	H	R	R	R	H		H			H	H	H		85
Sulfuric Acid	95-100%	B	W	R	R	H	R	H				H			86
Oleum	All		?	R	R	?		H				H			87

UNIVERSAL CHART NOTES

1. (a) More abrasive than corrosive
   (b) If alkaline, iron or steel may be used
2. (a) Copper alloys useable when unaerated
   (b) Stainless steels subject to pitting
   (c) Nickel and monel better in saturated solutions than dilute solutions
4. (a) Air unfavorable to nickel and monel
6. & 7. (a) If pH is above 7 then iron or steel may be used satisfactorily at room temperature
   (b) Stainless steels have a tendency to pit
9. - 11. (a) Copper alloys useless when air is present
12. (a) More abrasive than corrosive
13. & 14. (a) At high pH cast iron has fair resistance
   (b) Stainless steels tend to pit
   (c) 316 stainless is good when flowing but useless toward stagnant solutions
   (d) High chrome content beneficial
   (e) Nickel and monel catalyze reactions and are, therefore, unfavorable
   (f) Sodium hypochlorite has comparable characteristics
15. (a) Iron, steel, low alloy stainless steel, nickel and monel are useless when calcium sulfide is present
16. - 18. (a) Chlorine must be perfectly dry if iron, steel or copper alloys are to be used
19. & 20. (a) Iron and steel are satisfactory only in neutral solutions
   (b) Corrosion rate of Hastelloy "C" increases with concentration and/or temperature
21. & 22. (a) 18-8 stainless steel tends to pit
23. & 24. (a) Even in trace amounts promotes pitting in stainless steels
   (b) Best materials for handling this corrosive are non-metallic if possible
25. & 26. (a) Stainless steels tend to pit (Excess sulfuric acid should be avoided)
   (b) Monel is excellent for handling slurries of ferrous sulfate
   (c) Air mikes copper base alloys useless
27. & 28. (a) Copper is useless in presence of air
   (b) Monel is subject to stress corrosion
   (c) Glass, porcelain and stainless steels are safe in hydrofluoric acid free solutions

		Ni-Resist	Haveg	Copper and Amberloy	Everdur	Phosphor Bronze	Commercial Bronze and Red Brass	Porcelain	Glass	Tantalum	Permolite	Rubber	Asbestos	Karbate Impervious Graphite	
Sodium Deca Meta Phosphate	All	R	H	R	R	R	R	B	H		B	H	R	H	74
Sodium Meta Phosphate	All	R	H	R	R		R	B	H		B	H	R	H	75
Mono Sodium Phosphate	All	R	H	R	R		R	B	H		B	H	R	H	76
Sulfuric Acid	1-5%	R	H	H	H	H	H	B	B	B	B	B		B	77
Sulfuric Acid	5-10%	R	H	H	H	H	H	B	B	B	B	B		B	78
Sulfuric Acid	10-20%	R	H	H	H	W	H	B	B	B	B	B		B	79
Sulfuric Acid	20-40%	R	H	H	H	W	H	B	B	B	B	H		B	80
Sulfuric Acid	40-62%		W	R	W	R	R	B	B	B	B	H		B	81
Sulfuric Acid	62-75%	R		R	R	R	R	B	B	B	B			B	82
Sulfuric Acid	75-85%	R		R	R	R	R	B	B	B	B			H	83
Sulfuric Acid	85-90%	R		R	R	R	R			B	B			1H	84
Sulfuric Acid	90-95%	R		R	R	R	R			B	B				85
Sulfuric Acid	95-100%	R								B	B				86
Oleum		H								B	B				87

29. (a) 48 to 60 per cent, 185F

29. & 30. (a) Steel is satisfactory for solutions of 60 per cent and over at room temperature
(b) Red brass is subject to stress corrosion
(c) Copper base alloys, nickel and monel are useless in presence of air

32. & 33. (a) Copper alloys and monel useless in aerated solution
(b) Stainless steels and Carpenter No. 20 tend to pit
(c) Glass and ceramic are satisfactory in acid solution

39. & 40. (a) 18-8 and 440 stainless steels pit
(b) Cast iron, cast steel, 18-8 stainless steel are best right at the boiling point otherwise only use at room temperature

42. (a) Stainless steels tend to pit

45. (a) Cast iron, cast steel and Ni-Resist poor against aerated solutions or acid solutions

48. - 54 (a) Steel, 18-8 stainless steel, nickel and monel are subject to stress corrosion
1. Steel at 200 F any concentration
2. 18-8 stainless at 180 F above 60 per cent concentration
3. Nickel at 500 F above 90 per cent concentration
4. Monel at 650 F above 85 per cent concentration
(b) Teflon cannot be used with concentrated caustic solutions

55. - 65. (a) Copper base alloys nickel and monel are useless in aerated solutions
(b) Stainless steels are much improved by aerated solutions
(c) 18-8 stainless steel is subject to intergranular corrosion
(d) Glass and ceramic must have fluoride free solutions

66. - 76. (a) Items (68-70) can be improved by the addition of caustic for corrosion resistance by cast iron and cast steel
(b) Items (71-75) should never be used with cast iron or cast steel even in the presence of large excesses of caustic
(c) Glass and ceramic show excellent resistance to attack from acid solutions. However, they should not be used at control surfaces since there is a tendency toward mild pitting
(d) When boiling point is below 338 F

77 - 87. (a) Copper base alloys, nickel and monel are useless in aerated solutions
(b) Stainless steels should not be coupled with iron or steel under any circumstances
(c) Stainless steels are slightly improved by aerating the solutions
(d) Gray cast iron should not be used with Oleum because of interstitial corrosion and subsequent explosions
1. White cast iron is not so affected
(e) Cast steel should be limited to Oleum concentrations below 4 per cent and above 25 per cent for best results
(f) Stainless steels in general are better for higher Oleum concentrations

TABLE 2

Agitation—If flow is non-turbulent the selections in the tables are substantially correct. However, for velocities greater than 3 ft per sec or for turbulent flow change letter code by following table:

No change	Drop 1 point	Drop 2 points
Asbestos	Carpenter 20	Amberloy
Ceramic	Hastelloy B, C and D	Cast Iron
Glass	Monel	Cast Steel
Haveg	Nickel	Commercial Bronze
Karbate	Ni-Resist	Copper
Permolite	316 Stainless Steel	Everdur
Plexiglass	Tantalum	Phosphor Bronze
Rubber		Red Brass
		302 Stainless Steel
		304 Stainless Steel
		440 Stainless Steel

TABLE 3

For handling slurries the following materials are recommended for parts receiving severe wear:

Asbestos (impregnated with material being handled)
Ceramic
Chrome plate (resistance similar to 316 Stainless)
Glass
Hastelloy D
Karbate Impervious Graphite
Ni-Resist (hardened)
Permolite coating
Rubber (hard)
304 Stainless (hardened)
Vasco 7152 (hardened—resistance similar to 304 Stainless)

TABLE 1

If dissolved air is present in solution the following table should be used to modify selections: (Change letter code by indicated amount)

Drop 5 points	Drop 2 points	No change	Raise 2 points	Raise 4 points
Amberloy (A)*	Amberloy (B)**	Asbestos (B)	Ni-Resist (A)	302 S.S. (A)
Commercial Bronze (A)	Asbestos (A)	Carpenter 20 (A,B)	302 S.S. (B)	304 S.S. (A)
Copper (A)	Cast Iron (A)	Cast Iron (B)	304 S.S. (B)	316 S.S. (A)
Everdur (A)	Cast Steel (A)	Cast Steel (B)	316 S.S. (B)	
Phosphor Bronze (A)	Commercial Bronze (B)	Ceramic (A,B)	440 S.S. (A)	(300 series
Red Brass (A)	Copper (B)	Glass (A,B)		Stainless Steel
	Everdur (A)	Hast. B,C,D (A,B)	(300 series	in General)
(Copper Base Alloys	Karbate (A) hot	Haveg (A,B)	Stainless Steel	(A)
in General (A))	Monel (A)	Karbate (B)	in general)	
	Nickel (A)	Ni-Resist (B)	(B)	
	Phosphor Bronze (B)	Permolite (A,B)		
	Red Brass (B)	Plexiglass (A,B)		
		Rubber (A,B)		
		440 Stainless (B)		
		Tantalum (A,B)		

*A = Acid solution **B = Basic solution (alkaline)

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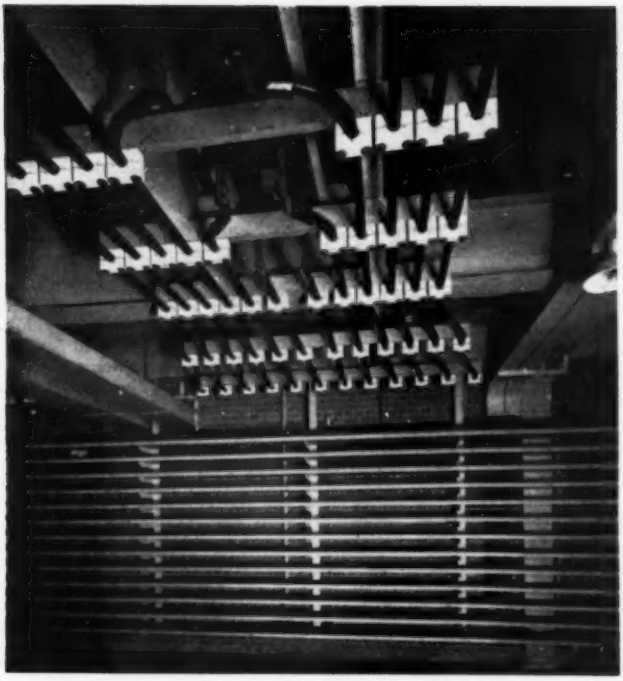

Pressed tube connectors are here used to join cables to the bus bar risers for the mercury arc rectifier installation on the floor above

WHAT'S DIFFERENT ABOUT CABLE CONNECTORS FOR ALUMINUM CONDUCTORS

Outwardly, the problems of joining aluminum conductors may not appear much greater than for copper. Yet expansion, hardness of material, corrosion and size are all factors which may contribute to slow deterioration of the connection and cause future trouble

FRANCIS A. WESTBROOK

INCREASED USE of insulated aluminum electrical conductors and cables in industrial plants has made the question of the proper type of connectors important. In many instances, connectors which are satisfactory for joining copper conductors are not suitable for aluminum-to-aluminum or copper-to-aluminum joints due to factors pointed out in recent literature.*

Aluminum is relatively soft so that if subjected to too much pressure in the connector, cold flow is liable to result. Also, if aluminum is connected to copper, measures must be taken to prevent galvanic action between the two metals, which will result in corrosion. There are also other problems that the advent of aluminum conductors in industrial plants has posed. These include effect of repeated heating and cooling of the joints due to fluctuations in electrical load, the greater space required by aluminum conductors when connected to existing switches and fittings designed for copper conductors, and the question of inter-strand resistance which is not the same with aluminum as with copper.

Protection Against Yield

Because of the softness of aluminum, it is essential that pressure exerted by the conductor be kept within limits which will not cause cold flow in either the connector or the conductors, assuming all three to be aluminum. This condition can be met by providing a contact area between the conductors and connector large enough to keep the unit pressure below that causing cold flow in any of the metal. The contact area should also be large enough to prevent excessive heating when overloads take place, otherwise annealing is liable to occur, permitting consequent loosening of the joint. At the same time, contact area and pressure must be sufficient to withstand the mechanical stress at the joint.

Obviously, requirements are different where low current densities are to be handled and where heavy currents are involved. Requirements also vary with different types of connectors, such as clamp or bolt connectors, or compression joints.

Frequent cycles of heating and cooling because of fluctuations in the electrical load can cause failure of the joint when the connector metal is different than the aluminum conductor. Because aluminum has a relatively high thermal coefficient of expansion, heating causes it to expand more than the metal of the connector, forcing the restrained, soft conductor to creep, or yield, longitudinally. Subsequent contraction or cooling may result in a loose connection, or the resulting pressure may warp the connector itself. This can be taken care of by using connectors so designed that the elastic limit in its parts will not be exceeded, or by having a spring in the assembly to absorb excess pressures.

Corrosion Protection

When the connector is of a different metal than the conductor, it is necessary to guard against galvanic corrosion. With a copper connector, aluminum conductors will corrode if moisture is present to form an electrolyte. Even when they are insulated, there may be

*Paper by Henry Dupre, Development Engineer, Burndy Engineering Company, at the 1951 AIEE Fall Meeting.

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moisture between the strands. Or moisture may gain entrance at exposed points in the circuit and appear at the joints, even though carefully taped. Only very small amounts of moisture are sufficient to provide an electrolyte and corrosion will occur unless preventive measures are taken.

Experience has shown that tinning the copper connector will correct the difficulty and at the same time leave it suitable for making connections between copper cables. On the other hand, if the connector is made of aluminum, it can be plated or tinned so as to be suitable for use with copper cables. Such a connector is, however, less desirable than one of tinned copper. A scratch or slight break in plating on aluminum will expose it to a comparatively large surface of copper (if used for the conductors), resulting in severe and rapid corrosion of the aluminum connector.

When an aluminum conductor is connected to one of copper, the aluminum should always be placed in the upper position. Otherwise, moisture carrying dissolved copper salts is liable to drip on it. The connecting electrolyte between the conductors will cause galvanic corrosion with ultimate destruction of the aluminum member.

High resistance between the strands of a cable at a joint is likely to result in a poor connection and should be prevented. This is best accomplished, as shown by tests, by inserting between the strands a compound having metallic particles of high conductivity. This breaks the oxide covering the individual strands so that a good electrical connection between them is established when the joint is made. The compound also prevents subsequent deterioration of the connection.

Size Factors

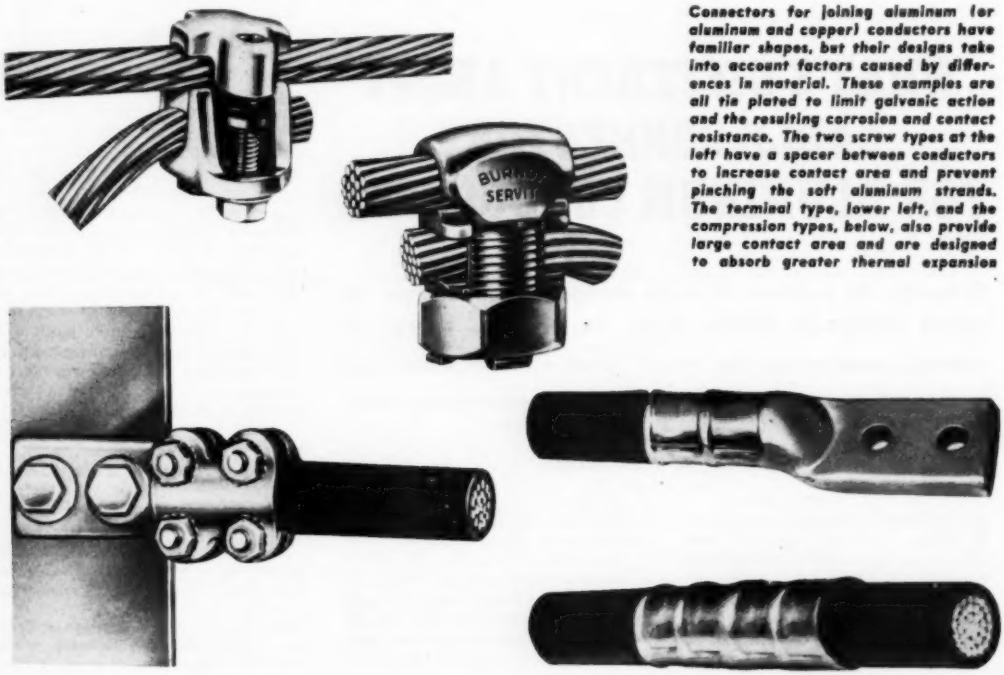
When aluminum cable is installed in industrial plants, it ordinarily has to be terminated in equipment such as switchgear and junction boxes originally designed for copper conductors. As electrical conductivity of aluminum is less than that of copper, the aluminum conductor will be somewhat larger and will require large entrance openings and more space. One answer is the use of aluminum cables with highly heat-resistant insulation so that over-all diameter will be the same as that of the copper cable for which the equipment was originally designed.

The effect of vibration on connectors in certain locations should also be taken into consideration on account of possible deterioration due to fatigue of the cable and connector metals.

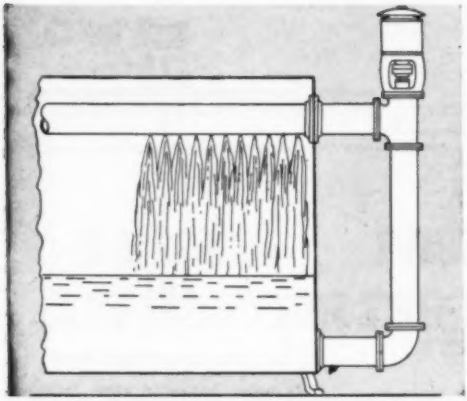
Existing Connectors

Another problem likely to be encountered is that equipment, whether new or existing, is provided with connecting terminals designed for copper conductors. In other words, the connectors ordinarily will not meet requirements described for aluminum conductors. In such cases, it is usually advisable to change the terminal connectors. This is, of course, an annoyance, but better than having trouble which may interfere with production schedules later.

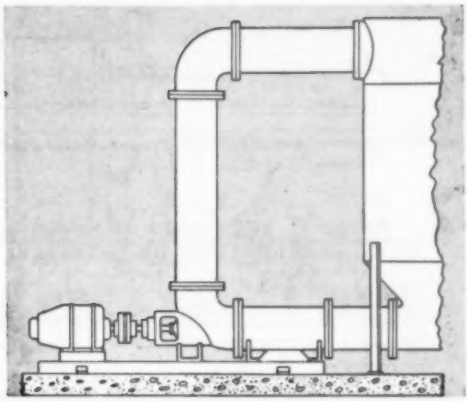
It goes without saying that the plant electricians should be aware of the requirements regarding the use of aluminum conductors. Actually they are not many, nor difficult to understand. Connector manufacturers have designs to meet most service. Types may be selected to fit conditions in a given plant and then standardized.



Connectors for joining aluminum (or aluminum and copper) conductors have familiar shapes, but their designs take into account factors caused by differences in material. These examples are all tin plated to limit galvanic action and the resulting corrosion and contact resistance. The two screw types at the left have a spacer between conductors to increase contact area and prevent pinching the soft aluminum strands. The terminal type, lower left, and the compression types, below, also provide large contact area and are designed to absorb greater thermal expansion



Pump shaft, either solid or hollow, extends below the water level in the tank with motor resting on top of standpipe



Circulating installation with the horizontal impeller is termed an elbow unit, and it is ideal for agitating services

AXIAL FLOW PUMPS ..... THEIR CHARACTERISTICS

Moving water and other fluids by means of axial flow pumps is coming to the fore, because of the flexibility of installation. Motors can be located above the operating floor with the shaft encased and extending to the impeller head many levels below

R. J. MacMEEKIN, *Chief Engineer*

Economy Pumps, Inc. Division C. H. Wheeler Mfg. Co.

AXIAL FLOW TYPE PUMPS are gaining increasing recognition. They are arranged so the pumping element discharges water into a passage surrounding the shaft. Water flow is along the shaft, hence the term *axial flow*. Rotation at any specific speed affords a design for any one of a wide range of combinations of capacity, head and speed.

Axial flow pumps commonly have axial flow impellers, but they often have mixed flow impellers and diffusers (bowls). These permit lower rotative speeds for a given head than do propellers, and they may be operated at higher heads. Consequently, axial flow pumps with mixed flow impellers are preferred for services requiring utmost reliability and long lift, such as pumping condenser circulating water.

Axial flow pump construction has a number of advantages over volute pumps. It lends itself particularly well to wet pit installation. There is no separate discharge pipe rising to the motor floor to interfere with withdrawal, other than to disconnect the flange to discharge piping of the dresser coupling. No radial thrust exists because diffusers are symmetrical and therefore hydraulically balanced. The small diameter of the diffuser leads to a small opening in the floor and a small motor base over the opening.

While volute pumps are suspended as sump type pumps in multitudes of instances, they are usually small pumps —up to 14 in. and occasionally larger. On the other hand, axial flow pumps are suspended in large sizes and 900 hp units have been in operation several years.

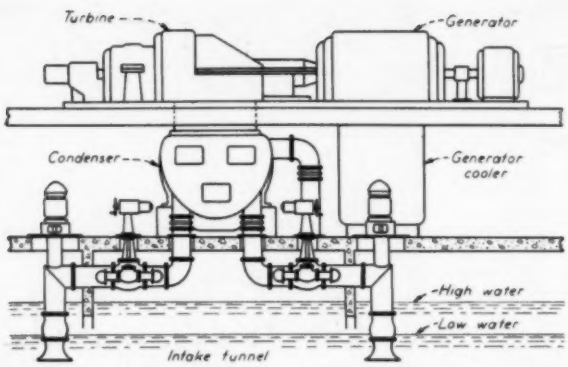
Motors can be placed above high water or flood levels, and settings of 50 to 100 ft are not uncommon. The pumps can be raised and one section after another removed at the motor floor when the time comes to recondition the pump.

One special design of axial flow pump has *pull-out* construction that may be either an above floor discharge or an underground discharge. Its purpose is to permit removal of wearing parts without breaking the discharge connection or withdrawing the entire unit. It is also of great advantage where tide or flood conditions—or even normal water level—lead to pressure at the motor floor. This condition occurs frequently, and withdrawing ordinary axial flow pumps is impossible because the water would rise through the floor opening. By using pull-out construction and extending the column so the motor base is above high level, removing the motor and motor base and withdrawing the pump bowl and rotor are possible without spilling water over the top of the column.

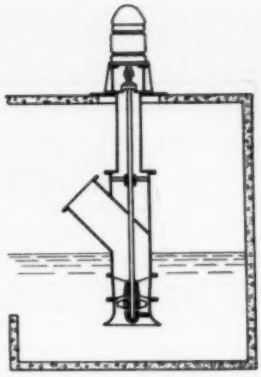
Withdrawable feature of the rotor without disconnecting the discharge is of great value when the pump is of the underground discharge design. In such an installation, the discharge connection is in a flooded chamber under the floor and may have to be reached in a boatswain's chair. This connection may also be submerged even though the water level does not reach the supporting floor. Pull-out pumps are best adapted for a short setting (distance from bell to supporting floor).

Thrust load, including impeller and shafting weight, is carried by a thrust bearing on top of the motor. This reduces the number of thrust bearings to one, and the motor manufacturer designs it according to the pump manufacturer's specifications.

While solid shaft motors can be provided with thrust capacity, hollow



Motors for these axial flow pumps, installed on the condenser floor above the maximum high water mark, are easily accessible for service in any emergency



This water lubricated pump, installed in a sump, has an angular discharge

shaft motors are generally standardized with generous extra thrust capacity. For instance, a 75 hp, 720 rpm hollow shaft motor has usually an external thrust capacity of 12,500 lb.

Rotor Adjustment

Pump rotor position can be adjusted from the motor floor. This is especially desirable in the case of the axial flow pump having open mixed flow impeller, because lowering the impeller takes up wear and allows for operation with the most favorable clearance. If a new installation is expected to pump sandy water at first, the rotor could be raised and then later lowered.

Adjustment is accomplished at the motor coupling, in the solid shaft motors and by turning a nut on the top of the motor, in the case of hollow shaft motors. The latter is much more convenient, particularly on large units. The motor coupling is not too accessible on solid shaft installations, and when the coupling parts are large and heavy manipulation becomes difficult.

Lubrication Method

Axial flow pumps are provided with different kinds of bearing and lubrication systems, according to the service. The simplest design has rubber bearings mounted in spiders and lubricated by the water pumped. This is satisfactory with clean water, and when the pump is not long, relative to the head developed. However, there must be enough head to keep water on the upper bearings. Rubber bearings can be enclosed in a coverpipe and supplied with clear water from a separate source if the pump handles dirty or corrosive water. Oil or grease lubricated bronze bearings are usually in a coverpipe. Oil is dropped from bearing to bearing from either a flooded or solenoid lubrication system. Another good arrangement is to pump oil through separate lines to each bearing. In this arrangement the oiler is belted to the pump shaft or preferably driven by a small motor.

Grease lubrication is usually preferred for flood control service. The grease forces out dirt and keeps a collar around the bearing ends. Such pumps may stand idle for months at a time, and the grease film keeps the bearing in condition ready for immediate operation.

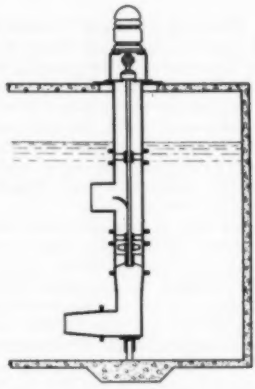
Staging

Axial flow pumps are frequently staged, that is, built with two or more impellers. This increases the developed head. Some manufacturers specialize in diffuser pumps of relatively small size but have many stages and great lengths. These are called *deepwell* pumps or sometimes *deepwell turbine* pumps, rather than axial flow.

Axial flow pumps with mixed flow impellers are likely to be used in two stages for such a condition as say, 30,000 gpm, 100 ft head. Such an application is too large to come under the deepwell heading, of course.

Mixed flow impeller designed for a certain set of conditions—head, capacity, suction condition and speed—has the same inlet design whether operated in a volute or with a diffuser. It has the same degree of sensitivity to suction conditions. On the other hand, the volute type is more frequently set at a higher level than the axial flow bowl. This results in less submergence or perhaps a suction lift and less favorable pump performance.

Sump design should always be given careful consideration. Poor design will lead to the formation of vortices, which will be picked up by the water



Special reverse flow pump arrangement for agitating heavy suspended solids

stream to the pump. Should this occur, there might be objectionable vibration and noise as the air entrainment disturbs the water distribution in the pump. This can be rectified by following good sump design practices. Sometimes, however, there are physical limitations that tend to interfere. In such cases, it may be worthwhile to arrange for a model test of the sump before installing the pump. This will show whether trouble is to be expected and at what points. Proper baffling can be worked out experimentally in the model.

Axial flow pumps are reliable machines. They are highly efficient and do not require priming when installed in a wet pit. They can also be installed vertically in a dry pit with water coming to the pump through a pipe bolted to the suction flange.

Power transmission

Engineering data and information to aid in selection, application and operation of equipment used in transmission of mechanical power

V-BELTS · · · · PROPER SELECTION AND APPLICATION FOR LOW COST OPERATION

Proper selection does not mean merely determining the length of a belt and ordering a new one. It goes deeper than this, as numerous factors enter the picture. Here are explanations of these factors with suggested common sense maintenance

C. J. BUSACCA, *Engineer, Allis-Chalmers Mfg. Co.*

IN this day of cost consciousness and material shortages it is desirable to obtain maximum service from all types of equipment and to be prepared for any contingencies. The proper selection and maintenance of equipment along with up-to-date service records or service charts will help insure continued production at lowest cost.

These factors are particularly true with respect to V-belt drives. And while correct selection and maintenance will help prevent premature drive failure, lack of proper records can still cause lost production. The reason for this will be explained later. First let us consider possible errors in drive selection.

Multiple V-belts are made in five standard sizes A, B, C, D and E. They are also made in standard, high-capacity, oil-resisting, oil-proof and static-conducting types. Several factors are involved in the correct choice.

To begin with, the belt cross section should be specified by the pitch diameter of the smallest sheave. Table 1 shows the minimum bending arc, or pitch diameter, over which any belt cross section should operate. Selection of a drive to operate over sheaves smaller than the recommended minimum will cause excess flexing, high internal heat and premature belt failure. Frequently, an 11 groove belt "C" section drive, operating over comfortable pitch diameter, will cost less, give longer life, require less tension, transmit the same power and will be easier on motor or driven machine bearings than will a 12 groove "D" section drive operating over too small pitch diameter but still traveling over 5000 surface ft per min.

In general, V-belt drives should operate between 1000 and 5000 surface fpm to transmit maximum horsepower.

TABLE 1 — RECOMMENDED SIZE DRIVING SHEAVE

Section	Minimum pitch diameter, inches	Maximum pitch diameter
A	3.0	Sheaves developing belt speeds in excess of 5000 ft per min are not recommended
B	5.4	
C	9.0	
D	13.0	
E	21.6	

TABLE 2 — ARC OF CONTACT—CORRECTION FACTOR

$$\text{Arc of contact} = 180 - \frac{60\ (D - d)}{C}$$

Arc	180	170	160	150	140	130	120	110
Factor	1.00	0.98	0.95	0.92	0.89	0.86	0.83	0.79

TABLE 3 — SERVICE FACTORS

Following are some of the more general applications with corresponding overload factors. (Reversing service requires an additional 1.2)

Agitators, paddle-propeller	1.0-1.2	Line shafts	1.4-2.0
Brick and clay machinery	1.2-1.6	Machine tools	1.0-1.4
Bakery machinery	1.0-1.2	Mills	1.4-1.6
Compressors	1.2-1.4	Oil field machinery	1.2-1.6
Conveyors	1.0-1.6	Paper machinery	1.2-1.6
Crushing machinery	1.4-1.6	Printing machinery	1.2
Fans and blowers	1.2-2.0	Pumps	1.2-2.0
Flour-feed and cereal mill machinery	1.0-1.4	Rubber plant machinery	1.4-2.0
Generators and exciters	1.2	Screens	1.2-1.4
Laundry machinery	1.2	Textile machinery	1.2-1.6

The service factor selected depends on peak and shock load in excess of 100% full load. Where shock and peak loads are light, use the lower service factor—for severe loads, use the higher service factor.

The savings in the number of belts used, and in the number of sheave grooves are obvious.

To select an adequate drive, the arc of contact (Table 2) of belts on the sheave should be closely checked, and the correct service factor (Table 3) for the type of load should be applied. If these two factors are not considered in selecting a drive, it might be under belted and fail prematurely.

Some drives must operate under extreme conditions of oil or grease or in an oil-laden atmosphere. For such applications, the choice of standard belts rather than the slightly higher cost oil resisting, oil proof or super-rated belts is false economy. Standard multiple belts are not designed to operate under these conditions and will not give the long life desired. Also, where explosion hazards exist, it is wise to select static conducting type belts, which are designed to dissipate the build-up of static electricity.

Where space or power limitations require the use of fewer belts than would be necessary using standard multiple V-belts, a super-rated type belt is now available. Information on features and capacities of each of the belt types to meet specific operating conditions can be obtained from the manufacturer.

Giving heed to the above mentioned factors offers a comparatively simple choice of the correct belt for the job. Equally easy is maintenance of the drive, provided several basic rules are followed. Here they are.

Don't allow the V-belts of any drive to operate so loosely that they slip. Slipping belts cause surface wear, generate heat and fail prematurely. Properly taut V-belts have an alive springiness when thumped by the hand, while loose V-belts feel dead.

Don't use new V-belts with old belts on the same drive. This is false economy as the new belts are shorter and will attempt to pull all the load. The old belts will slip and grab alternately and may soon be broken.

Check sheave grooves for wear. Ridged, potted or corroded grooves will have an abrasive action on the belts causing them to wear unduly.

When breaking in a new set of belts, be sure to check tension after the first 24 hr. All belts stretch some during the run-in period and this initial stretch should be removed by taking up the belt to restore tension on the drive.

Belts should never be pried, forced or rolled into the groove. The motor or idler should be loosened to allow the easy placing of the belts in the grooves. Prying may break the internal pulling cords and cause failure.

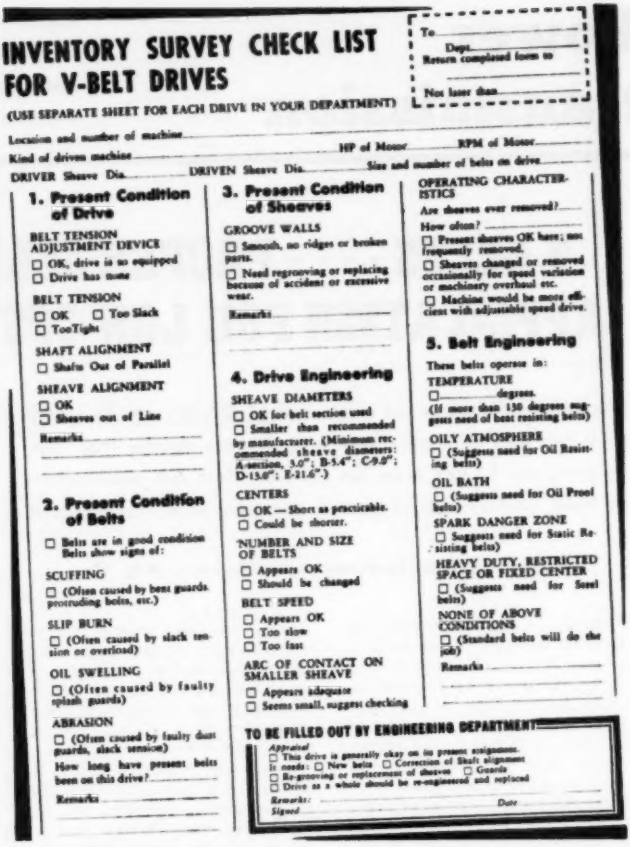
Although most V-belts are well designed and well made, they should be protected from falling objects, protruding bolts, or excessive abrasive material. Drive guards are the practical solution, but they should be designed to allow circulation of air. Where so constructed, a V-belt will operate in ambient temperatures up to 160 F.

The next step essential to maintaining production and saving dollars in lost time due to drive failure is to keep adequate operating and drive catalog records. These records can save time often spent in trying to figure out or remember exactly what size drive is on any given machine.

Generally, it is impossible to read the belt size on the belts of a drive, which has operated for several years. Any attempt to check size is frequently difficult because of belt stretch, or deterioration. A record of the drive catalog kept on a sticker attached to the machine or to the drive guard and recorded in the office files will save much down-time by making possible quick ordering of the exact belt from the supplier.

When the belts are not a stock size in the community, an operating record of the drive will make possible the anticipating of possible drive failures and thereby assuring availability of the proper number of belts of the correct size in a matched set for immediate installation.

A copy of one type of V-belt record chart is shown. Most V-belt manufacturers have similar record charts and stickers for recording the drive catalog on the drive guard or near the drive on the machine itself. A survey and record of the drives in a plant, conducted by the plant engineer, will assist materially in keeping production schedules up to date.



INVENTORY SURVEY CHECK LIST FOR V-BELT DRIVES

(USE SEPARATE SHEET FOR EACH DRIVE IN YOUR DEPARTMENT)

To ____ Dept. ____ Return completed form to ____ Not later than ____

Location and number of machine ____

Kind of driven machine ____ HP of Motor ____ RPM of Motor ____

DRIVER Sheave Dia. ____ DRIVEN Sheave Dia. ____ Size and number of belts on drive ____

1. Present Condition of Drive

BELT TENSION ADJUSTMENT DEVICE
☐ OK, drive is so equipped
☐ Drive has none

BELT TENSION
☐ OK ☐ Too Slack
☐ TooTight

SHAFT ALIGNMENT
☐ Shafts Out of Parallel

SHEAVE ALIGNMENT
☐ OK
☐ Sheaves out of Line

Remarks ____

2. Present Condition of Belts

☐ Belts are in good condition
Belts show signs of:

SCUFFING
☐ (Often caused by belt guards protruding bolts, etc.)

SLIP BURN
☐ (Often caused by slack tension or overload)

OIL SWELLING
☐ (Often caused by faulty splash guards)

ABRASION
☐ (Often caused by faulty dust guards, slack tension)

How long have present belts been on this drive? ____

Remarks ____

3. Present Condition of Sheaves

GROOVE WALLS
☐ Smooth, no ridges or broken parts.
☐ Need regrooving or replacing because of accident or excessive wear.

Remarks ____

4. Drive Engineering

SHEAVE DIAMETERS
☐ OK for belt section used
☐ Smaller than recommended by manufacturer. (Minimum recommended sheave diameters: A-section, 3.0"; B-5.4"; C-9.0"; D-13.0"; E-21.6".)

CENTERS
☐ OK — Short as practicable.
☐ Could be shorter.

NUMBER AND SIZE OF BELTS
☐ Appears OK
☐ Should be changed

BELT SPEED
☐ Appears OK
☐ Too slow
☐ Too fast

ARC OF CONTACT ON SMALLER SHEAVE
☐ Appears adequate
☐ Seems small, suggest checking

OPERATING CHARACTERISTICS
Are sheaves ever removed? ____
How often? ____
☐ Present sheaves OK here; not frequently removed.
☐ Sheaves changed or removed occasionally for speed variation or machinery overhaul etc.
☐ Machine would be more efficient with adjustable speed drive.

5. Belt Engineering

These belts operate in:

TEMPERATURE
☐ ____ degrees.
(If more than 130 degrees suggests need of heat resisting belts)

OILY ATMOSPHERE
☐ (Suggests need for Oil Resisting belts)

OIL BATH
☐ (Suggests need for Oil Proof belts)

SPARK DANGER ZONE
☐ Suggests need for Static Resisting belts)

HEAVY DUTY, RESTRICTED SPACE OR FIXED CENTER
☐ (Suggests need for Steel belts)

NONE OF ABOVE CONDITIONS
☐ (Standard belts will do the job)

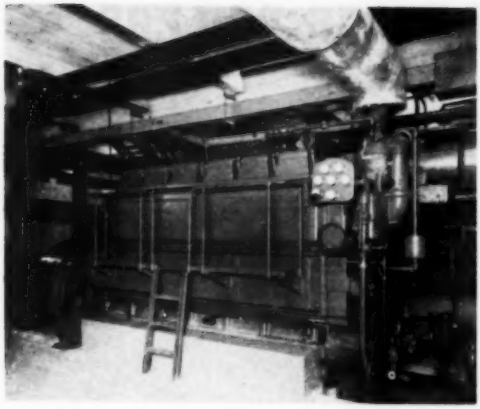
Remarks ____

TO BE FILLED OUT BY ENGINEERING DEPARTMENT

Appraisal
☐ This drive is generally okay on its present assignment.
It needs: ☐ New belts ☐ Correction of Shaft alignment
☐ Re-grooving or replacement of sheaves ☐ Guards
☐ Drive as a whole should be re-engineered and replaced

Remarks: ____
Signed ____ Date ____

Most manufacturers have charts available, similar to this one, that can be utilized to keep a complete record of a drive for profitable V-belt service



KALAMAZOO PAPER DIESEL PRODUCES EMERGENCY POWER

Here is an installation where one 865 hp standby diesel driving a 600 kw generator eliminates the need for utility power service, insures operating continuity, and aids weekend maintenance activity

WILLIAM H. GOTTLIEB, *Consultant*

THE KALAMAZOO PAPER CO. utilizes six big paper machines and two coating divisions to produce vast amounts of book and coated papers. These operations require large quantities of process steam, and consequently the company uses eight steam turbines with combined capacity of 20,000 kw to provide by-product electric power. Process steam requirements exceed power needs and the turbines are in effect reducing valves in the system.

For six days each week, the mill and its two power plants run a full schedule, but on Sundays, activity is cut to a minimum and electric load drops as low as 1000 kw. During this low load period only one boiler and one turbine are operated, and since all pumps and fans are electrically driven, the entire plant would be down if the turbine stopped. Some other source of power would be essential not only to restore operations but to run the motor driven fire pumps if an emergency developed. Finally, power is required for Sunday maintenance work on the paper machines and other mill equipment.

Kalamazoo management decided that a diesel would be the most economical and dependable means of providing standby power. Since competent operating personnel is on hand at all times, this arrangement was found to be considerably cheaper than paying a power company for standby service. Mindful of the potential importance of the equipment, a heavy duty, six cylinder, four cycle diesel with exhaust driven turbocharger was selected, rated 865 hp at 600 rpm. This unit drives a 600 kw, 3 phase, 60 cycle, 480 v synchronous generator with 7½ kw, 125 v, V-belted exciter. This assembly can drive the water pumps, mechanical draft fans and fire pumps in an emergency or power the largest piece of machinery in the mill when assisting in plant maintenance. Whether needed or not, the diesel is run once a week to insure that it will be ready for immediate service.

Fuel Economy

Fuel economy is not a major consideration in an operation of this kind but it is interesting to note the efficiency that has been achieved. Reports show that the engine averages 13.57 kwhr per gal of fuel consumed and recently during a one hr run, the diesel produced an even 500 kwhr on 33.3 gal of fuel or 15 kwhr per gal. The fuel used is a No. 1 oil, low in sulfur, which is delivered at 11.5 cents a gallon. Fuel is stored in a 12,000 gal underground tank and is transferred by an automatic float controlled motor driven pump through a meter to a 300 gal day tank in the engine room, which supplies a booster that feeds the six injection pumps.

Jacket water is circulated through the engine and a shell and tube heat exchanger by a 2½ in. centrifugal pump driven by a 7½ hp motor. This cooling system is fully automatic, a thermostatic control maintaining jacket temperature at the desired level by bypassing water around the exchanger. For makeup, a float control valve in the surge tank admits distilled water from the boiler condensate supply as needed. While the main pumps that provide filtered Kalamazoo River water for the mill send raw water through the heat exchanger and lubricating oil cooler, the diesel has an emergency line to the mill's fire system water tower.

There is a convenient gage panel on the engine with a multipoint exhaust pyrometer and pressure gages for all essential items. An alarm system warns in case of high jacket temperature, low lubricating oil pressure or low jacket water pressure. Since the engine would be urgently needed if no electricity were available, the starting air compressor includes an alternate gasoline engine drive in addition to the usual electric motor.

The company has no utility line and even if the diesel did not run at all, it would be saving money in standby charges. Actually, the engine has been called on to perform its primary functions, to operate steam plant auxiliaries in an emergency and to provide power for week-end mill maintenance. It is hard to put a price on such services except to say that they are essential.

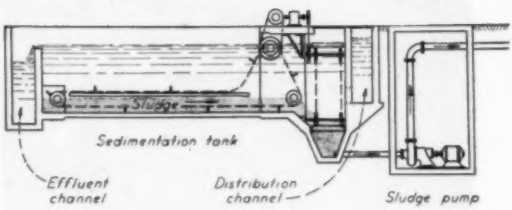
PRINCIPAL EQUIPMENT IN THE STANDBY DIESEL PLANT

Engine	Worthington Corp.	Cooling water pump	Worthington Corp.
Generator	Electric Machinery Mfg. Co.	Heat exchanger	The Sims Co.
Governor	Woodward Governor Co.	Thermostatic valve	Robertshaw-Fulton Controls Co.
Turbocharger	Elliott Co.	Starting air compressor	Worthington Corp.
Fuel oil	Standard Oil Co. (Indiana)	Air filter	Air-Maze Corp.
Fuel transfer pump & meter	Worthington Corp.	Exhaust silencer	The Maxim Silencer Co.
Lubricating oil	The Texas Co.	Exhaust pyrometer	Alnor Instrument & Pyrometer Co.
Lubricating oil filter	Cuno Engineering Corp.	Alarm system	Viking Instruments, Inc.
Lubricating oil cooler	The Sims Co.	Gages	James P. Marsh Corp.

SEWAGE GAS FIRED PACKAGE BOILERS

Methane gas evolved during the sewage digestion process supplies this plant with enough 625 Btu per cu ft fuel to fire steam generators and gas engines driving alternators and effluent pumps

A M RAWN, *Chief Engineer and General Manager*
S. R. SANDERS, *Electrical Engineer*
County Sanitation Districts
Los Angeles County, California



THE sewage treatment process used at the Joint Disposal Plant of the Los Angeles County Sanitation Districts is technically referred to as a primary sedimentation-separate sludge digestion system. With this arrangement, sewage enters the plant through bar screens, which remove any large floating objects that would damage pumping equipment, and is then pumped to large concrete settling tanks. Here the velocity is such that dense solids settle out while oils, greases and other floatable materials are removed with a water jet skimming system. The overflow, termed primary effluent, passes through a six mile long tunnel under the Palos Verdes Hills and two pipelines laid on the ocean floor before discharging one mile offshore at a depth of 110 ft. An idealized cross section of this installation is shown in Fig. 1.

Sludge Conditioning

Both dense and floatable materials removed during the sedimentation process are termed raw sludge. All heavy solids are dragged along the bottom of the tanks to hoppers at one end by wooden scrapers attached to continuous chain drives. Then this dense sludge is pumped to conditioning tanks where it is combined with the floatable materials that were previously removed by the skimming system and heated from about 75 to 100 F. The steam for this operation, generated by package boilers installed in 1948, is injected downward from headers along both sides of the conditioning tanks through several nozzles submerged to a depth of about 12 ft. As the steam rises, it creates a bubbling action that agitates the sludge and provides even heating.

Sludge Digestion

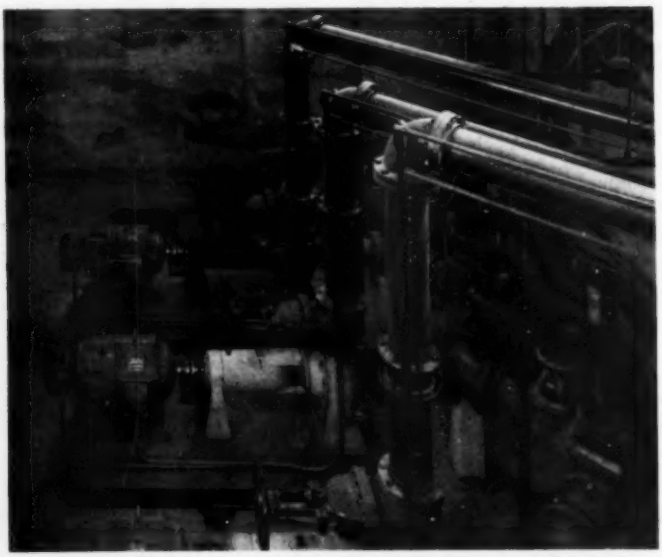
From the conditioning tanks the heated sludge is pumped to large airtight concrete tanks, called sludge digesters. Here bacteria reduce the organic matter, changing it into carbon dioxide, methane, inorganic residue, and water. When sufficient volatile organic matter has been digested to render the material innocuous and free from harmful bacteria, it is pumped to large beds surrounded by dykes and allowed to dry. After drying, a private contractor removes the sludge for processing and distribution to farmers and nurseries as an excellent fertilizer.

Gas System

During the digestion period enough methane gas is evolved to provide all the fuel required at the plant for power generation, pumping, and boiler operation. This gas has a lower heat content of approximately 625 Btu per cu ft with a chemical analysis as follows:

	Per cent
Methane	67.5
Carbon dioxide	32.4
Nitrogen	0.041
Carbon monoxide	0.83
Hydrogen	0.02
Oxygen	0.004
Hydrogen sulfide	0.0043
Ammonia	0.00025

All gas from the various stages of the digesters is collected by 3 and 4 in. lines that terminate in headers connected to 8 and 10 in. gas mains, which distribute it throughout the plant. Operating pressure on the system may vary from 6 to 10 in. wg with excess gas being burned through from one to



All pumps that are used to transfer sludge between various sections of the treatment system are conveniently located in the main boiler house

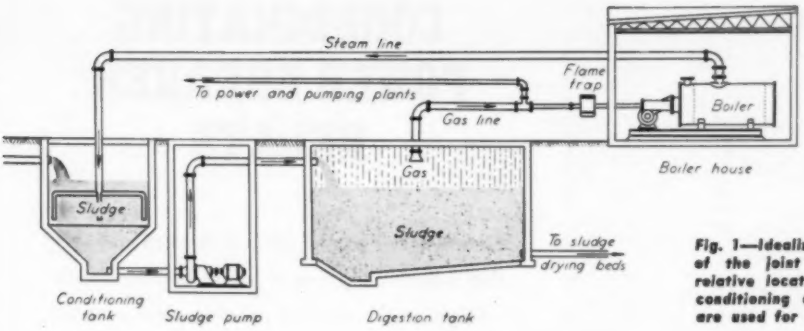


Fig. 1—Idealized cross sectional drawing of the joint disposal plant illustrates relative locations of the sedimentation, conditioning and digestion tanks which are used for processing primary sewage

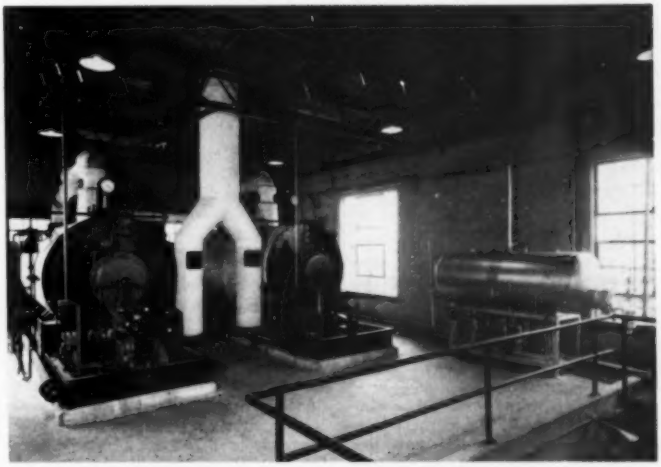
three waste burners whenever required.

An 8 in. main carries gas to the boiler house and supplies two steam generators through individual 4 in. feeders and pressure regulators. These boilers are four pass, down draft, horizontal fire tube, package type units with integral burner assemblies and controls, each rated 5000 lb of steam per hr from and at 212 F. One boiler supplies all steam for the sludge heating process whiles the other serves as a standby. All operations are fully automatic, and the generators are equipped with safety devices that provide flame failure, low water and excess pressure protection.

Boiler Feedwater

Since all steam is injected directly into the sludge, there are no condensate returns, and the plant operates on 100 per cent makeup water drawn from wells located on the plant site. This feedwater is softened before entering a preheater that raises the temperature from approximately 65 to 200 F with steam drawn from the boilers.

All steam generating and sludge pumping equipment is located in the boiler house adjacent to the sedimentation and conditioning tanks. As normal operating pressure is less than 15 psig, a 10 in. header is used to supply an 8 in. steam line that feeds the three conditioning tanks. Sludge is heated in one tank while a second is being filled or pumped to the digesters. The third tank serves as a standby unit.



Two sewage gas fired package boilers, each rated at 5000 lb per hr, supply steam at 15 psi pressure for heating the sludge in the conditioning tanks

A propane standby system has also been installed to supply fuel during emergencies. This equipment consists of a propane-air mixing unit that provides 625 Btu fuel in case serious trouble should occur in the digesters. To date it has not been necessary to use gas mixtures from this standby unit.

PRINCIPAL EQUIPMENT AT THE JOINT DISPOSAL PLANT
COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY, CALIFORNIA

Power plant	
Engines	Ingersoll-Rand Co.
Generators	General Electric Co.
Sludge pump and boiler house	
Boilers	Cleaver-Brooks Co.
Sludge pumps	Peerless Pump Div., Food Mach'y. & Chem. Corp.
Sludge pump motors	General Electric Co.
Sewage pumping plant No. 1	
Raw sewage pumps	Fairbanks, Morse & Co.
Raw sewage pumps	Worthington Corp.
Raw sewage pump motors	Fairbanks, Morse & Co.
Raw sewage pump motors	General Electric Co.
Sewage pumping plant No. 2	
Angle flow pump	Fairbanks, Morse & Co.
Angle flow pump motor	Fairbanks, Morse & Co.
Magnetic pump drive	Electric Machinery Mfg. Co.
West pump house	
Sludge pump	Peerless Pump Div., Food Mach'y. & Chem. Corp.
Sludge pump motor	General Electric Co.
South pump house	
Sludge pumps	Peerless Pump Div., Food Mach'y. & Chem. Corp.
Sludge pump motors	General Electric Co.
Sludge pump motors	U.S. Electrical Motors, Inc.
Effluent pumping plant No. 1	
Mixed flow pumps	Fairbanks, Morse & Co.
Mixed flow pumps	Peerless Pump Div., Food Mach'y. & Chem. Corp.
Mixed flow pump engines	Climax Engineering Co.
Mixed flow pump motors	General Electric Co.
Mixed flow pump motors	Westinghouse Electric Corp.
Effluent pumping plant No. 2	
Mixed flow pumps	Peerless Pump Div., Food Mach'y. & Chem. Corp.
Mixed flow pump engines	Ingersoll-Rand Co.

COORDINATING POWER BREAKER RELAYS

Choosing the proper relay calibration curve so that selective tripping of power breakers limits outages to the smallest possible plant area is tedious when a definite time spread is desired. This method of tracing and superimposing curves illustrates proper coordination easily obtained

FRANK E. REEVES, *Electrical Engineer*

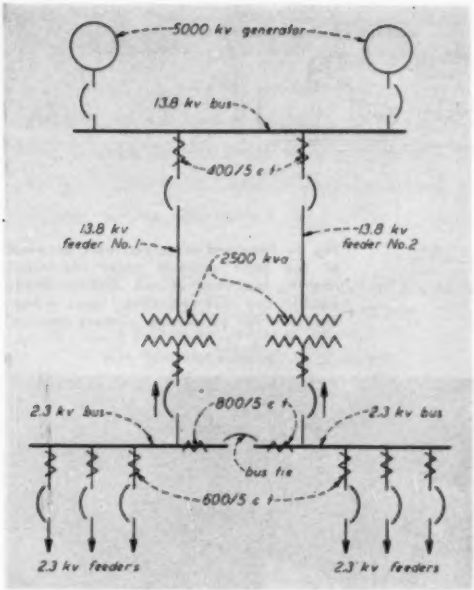


Fig. 1 —In selective tripping, the breaker nearest fault should trip first. If, after a short interval, it has not interrupted the current, the next breaker should operate

SELECTIVE TRIPPING of the breakers in an electrical distribution system is desirable in most industrial installations so that area affected by a fault may be localized to the greatest possible extent.

In the distribution system shown in Fig. 1, for example, the source, which in this case may be considered to be the 13.8 kv bus, supplies the two primary substation transformers through a power breaker for each. Transformer secondary breakers connect them to the 2.3 kv buses arranged in a secondary selective connection. The 2.3 kv feeders, protected by individual power breakers, supply the load center substations.

Each load center unit, in turn, has its own low voltage distribution system. A fault on the utilization feeders should be localized in its own area as much as possible. In any case, it should be cleared before it causes the 2.3 kv feeder breaker to trip and interrupt power to other substations connected to the same feeder.

Similarly, fault or overload conditions on one of the distribution lines should trip the feeder breaker before the primary transformer secondary breaker opens and deenergizes all feeders and associated load areas connected to it.

Although the method described here might be extended to include the load center breakers, the low voltage type normally have an instantaneous trip for short-circuit currents and are relatively fast acting on overload. On the other hand, power breakers used in the primary system generally have an eight cycle operating time, even on short circuit. Fault and overload conditions on the low voltage systems are thereby almost automatically restricted to load center areas if breakers have been properly sized and operate properly.

Power Breaker Tripping

Tripping of power breakers is nearly always initiated by relays energized by current transformers in each of the phase leads. The relays normally have a definite inverse time characteristic providing faster operation on high currents than on low overloads, which may exist longer without damaging cables and other equipment. The characteristic may be matched to the feeder current first by choosing the proper current transformer ratio and (in the relay itself) by tap and lever settings.

The manufacturer provides time-current calibration curves for each tap and lever setting. In order that the breaker nearest the fault may operate first, it is necessary that its curve be lower by a definite margin of time and current than the curve for the breaker relay next in line towards the source. Unless all curves are plotted on the same sheet, it is necessary to make a point by point comparison to insure the proper spread.

However, if the curve selected for the first breaker is transferred to a sheet of plain tracing paper, along with the principal coordinates, it may be placed over the manufacturer's curves for the next breaker relay and shifted horizontally until the current scales at the bottom align on the overlapping portions. It will then be a simple matter to select the curve (from the family of curves on the underlying manufacturer's sheet) which gives the best spread in time and current.

Many, if not all, of the curves involved may be traced directly. Only one tracing need be made as the proper curves and tap settings may be selected by sliding the tracing paper sidewise over the printed curves in the instruction book, with the horizontal current scale determining the amount of overlapping of the graphs.

Original Characteristic

One curve should be traced as a starting point. This is usually for the breaker in the heaviest radial feeder at the most remote point. In Fig. 1, it was the characteristic selected for the heaviest 2.3 kv feeder. Relays for the feeders were the "very inverse" type due to heavy air conditioning and fan load.

The setting, or curve, was determined by the initial current occurring when the heaviest circuit was reenergized after a 15 or 20 min outage, and also by the duration of the abnormally high current. After such an outage in the hottest weather, all air conditioning motors (fan, pump and refrigera-

tion motors) must be considered connected, and the breaker must carry the starting currents for all of them.

Fig. 2 is shown only to illustrate the principle involved. Only the left hand edge of Sheet No. 1, on which the curve for the 2.3 kv feeder has been traced, is shown. A "starting current" of 480 amp primary current was selected, and the scale starts at 720 amp, or 1.5 times 480. The current transformer ration is 600/5 and represents a tap setting of 4 in the relays. A time lever setting of 1.0 was used.

In the example, it was assumed that relay settings would not be made initially with actual test current. It was therefore felt advisable to allow a minimum of 0.5 sec spread between curves. When relays are set and tested regularly with actual current, a spread of 0.3 sec is usually satisfactory.

Backup Protection

In case of feeder breaker failure or fault on the 2.3 kv bus, the bus tie breaker should operate. By placing the tracing designated as Sheet No. 1 over the manufacturer's time-current curves for the tie breaker relay and sliding it sidewise, until current scales align, the proper curve may be selected. A characteristic representing current tap 4 and time lever 7 was found to be most satisfactory in this case. Note that the multiples of tap settings for both sheets change, but the 2.3 kv scale appears as a continuous scale since this current determines the position of one curve sheet with respect to the other.

Relays on the 2.3 kv side of the power transformers are directional and do not enter into this discussion. After selecting the tie breaker curve, it may be traced and superimposed on the manufacturer's curves for the 13.8 kv, primary feeder breaker relays and a suitable setting selected. The 2.3 kv amperes must, of course, be divided by 6 to obtain the corresponding 13.8 kv amperes, due to the 6 to 1 ratio of the 2500 kva power transformers. In this case, with 400/5 current transformers on the 13.8 kv feeders, a tap setting of 4 and a lever setting of 7 was selected for the relays.

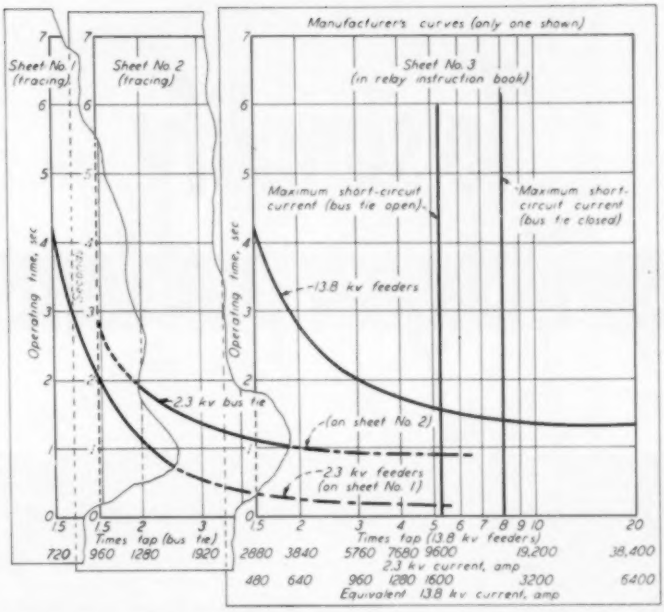

Manufacturer's curves (only one shown)
Sheet No. 1 (tracing)
Sheet No. 2 (tracing)
Sheet No. 3 (in relay instruction book)
Maximum short-circuit current (bus tie open)
Maximum short-circuit current (bus tie closed)
Operating time, sec
13.8 kv feeders
2.3 kv bus tie
(on sheet No. 2)
2.3 kv feeders (on sheet No. 1)
Times tap (bus tie)
Times tap (13.8 kv feeders)
2.3 kv current, amp
Equivalent 13.8 kv current, amp

Fig. 2—By tracing, on Sheet No. 1, the time-current curve for the first breaker to operate, it may be superimposed on the set of curves for the next breaker relay, allowing easy comparison. Procedure is similar on the successive breakers

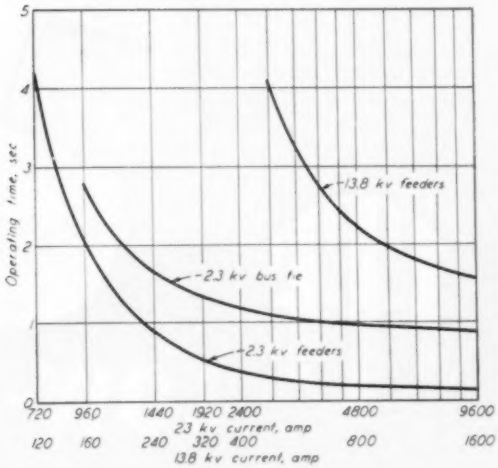


Fig. 3—As each of the curves is selected, it is traced or plotted on the same sheet. Only principal coordinates in the area of the curves need be traced. Note that time spread at any current is shown, although the value for short circuit conditions is the one usually specified and considered to be the most important

Actual Procedure

Actually, only one sheet need be used as shown in Fig. 3 if each successive curve, after being selected, is traced on that sheet. Only the major coordinates should be drawn. The coordinates in Fig. 3 were traced from the manufacturer's time-current curves as applied to the most heavily loaded 2.3 kv feeder. In order to show what happens for currents above 9600, a second sheet with the current scale starting at 2880 amp would show coordination at very high currents.

Such a relay study cannot be made intelligently without calculating short-circuit currents. Maximum short-circuit currents under various operating schedules should be shown on the curves as in Fig. 2.

When Chart Scales Vary

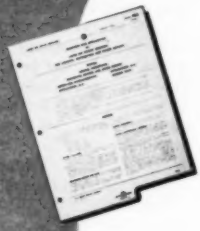
In this problem, all overcurrent relays were of the same manufacture and the particular manufacturer's time-current curves were found to be plotted on graphs having the same size and the same scales. All curves could therefore be traced directly from the instruction book curves. If graphs are of different sizes or if scales vary, some of the curves must be plotted point by point. The great saving in time by direct tracing of curves would be augmented by standardization of graph sizes.

To simplify switchgear problems...plan your

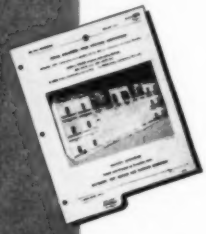
***BEFORE YOU SPECIFY*—SEND FOR YOUR FREE COPIES OF THIS INFORMATIVE I-T-E LITERATURE**

I-T-E Selection and Application Data is specially prepared by I-T-E application engineers to help you through the important steps in planning your switchgear system.

CATALOG SECTION 1003—Comprehensive, illustrated 50-page catalog contains complete data on selection and application of I-T-E low-voltage air circuit breakers and individually enclosed circuit breakers (Urelites).



CATALOG SECTIONS 1104, 1304, 1404, 1504—Detailed description of construction, operation, and application of I-T-E's KA, KB, KC, and LG circuit breakers—and I-T-E's full line of auxiliary and trip devices. Catalogs give you useful tables, wiring diagrams, mounting instructions, and dimensions.



CATALOG SECTION 6004—gives full information on I-T-E Multumite metal-enclosed, low-voltage switchgear. Completely describes I-T-E drawout construction and cubicle design. Contains useful specifications, dimensions, and suggestions for planning your metal enclosures.

FREE

I-T-E CIRCUIT BREAKER CO.
Switchgear Division, Dept. IP
19th and Hamilton Sts.
Philadelphia 30, Pa.

Please send me the catalogs which I have checked:

- ☐ Catalog Section 1003
- ☐ Catalog Sections 1104, 1304, 1404, 1504
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I-T-E

LOW-

I-T-E CIRCUIT

Canadian Mfg. & Sales:

layout from CIRCUIT BREAKER up

I-T-E CAN SUPPLY INDOOR AND OUTDOOR EQUIPMENT IN RATINGS:

15,000 to 100,000 amperes interrupting
600 volts a-c, 250 volts d-c
to 6,000 amperes continuous, a-c or d-c
to 10,000 amperes continuous, d-c only

Expansion or modernization of your electrical distribution system calls for detailed analysis. Before you can properly select your system and equipment, you must consider such important factors as load, power supply, circuits, *protection*, and *reliability*.

This means getting down to fundamentals. And, fundamentally, system reliability depends on *circuit breaker* protection. That's why it pays to think of your switchgear requirements *first of all* as circuit breaker applications.

Follow these three simple steps when planning your switchgear layout. You can then be sure that the circuit breakers you buy will provide the protection you need:

- **KNOW YOUR APPLICATIONS**—their load characteristics, protection requirements, need for continuity of service;
- **KNOW THE CIRCUIT BREAKER** features and functions that will satisfy all application requirements;
- **KNOW THE MANUFACTURER**—his ability to help you solve your problems and provide the best breakers for the job.

I-T-E experience and specialists are at your service. Your local I-T-E application engineer will gladly work with you on any switchgear problems. Get to know him. Give him a call—*today*.

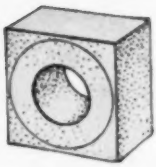
VOLTAGE SWITCHGEAR

BREAKER COMPANY • 19TH AND HAMILTON STS. • PHILADELPHIA 30, PA.

Eastern Power Devices, Ltd., Toronto • Export Sales: Philips Export Corp., N. Y. 17, N. Y.

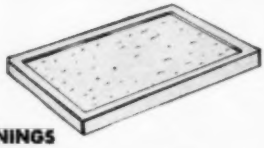
There's no end to the uses of economical

B&W KAOCAST



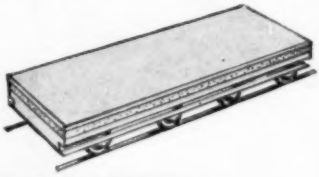
BURNER BLOCKS

Kaocast lasted 3 to 6 times as long as previous refractory. Still going strong.



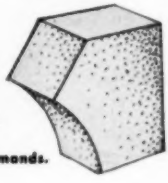
DOOR LININGS

Kaocast lasted 3 to 6 times as long as previous refractory—cut installation cost in half.



TUNNEL KILN CAR TOPS

Ordinary fireclay crumbled after few trips. Kaocast lasted 30 trips without deterioration.



SPECIAL SHAPES

Kaocast special shapes cast over week-end to meet production demands.

BOILER FURNACE REPAIRS

One power plant keeps a ton of Kaocast on hand for miscellaneous repairs because it is so versatile.

The list of plants who are discovering new, cost-saving uses of versatile B&W Kaocast keeps growing all the time. The reasons? This unique 3000 degree refractory castable can be molded in a hurry . . . cast directly in place . . . applied with a cement gun. It eliminates the need for a large inventory of special shapes. It has high resistance to spalling, low volume change, practically no reheat shrinkage. Want to know more? Ask your B&W Refractories Engineer—or write for Bulletin R-22.

BABCOCK & WILCOX

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REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R-45a

B&W REFRACTORIES PRODUCTS—B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • OTHER B&W PRODUCTS—Stationary & Marine Boilers and Component Equipment . . . Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

Handbook for engineered plant services

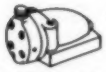
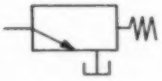
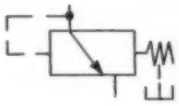
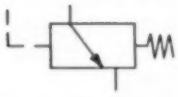
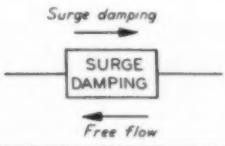
Methods, data and ideas that make excellent references in solving engineering problems frequently encountered in plant operations

RECOMMENDED HYDRAULIC SYMBOLS

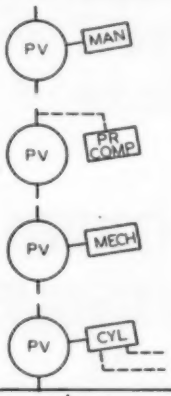
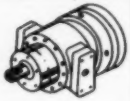
Hydraulic symbols in this article and following issues will aid the engineers responsible for engineered plant services in setting up an adequate program in the plant. These data have been suggested and approved by the Joint Industrial Conference. Their usage will coordinate your work.

Courtesy of the Denison Engineering Co.

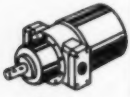
PRESSURE CONTROL VALVES

PRODUCT	PRESSURE	SIZE	TYPE	SYMBOL
 Subplate body shown. Relief valve	100 to 5000 psi	3/4	Threaded body or subplate	
		1 1/4	Threaded body, subplate or flange	
		1 1/2	Subplate or flange	
Threaded body shown Sequence valve	100 to 5000 psi	3/4	Threaded body or subplate	
		1 1/4	Threaded body, subplate or flange	
		1 1/2	Subplate or flange	
Threaded body shown Unloading valve	100 to 5000 psi	3/4	Threaded body or subplate	
		1 1/4	Threaded body, subplate or flange	
		1 1/2	Subplate or flange	
Surge damping valve	To 3000 psi	1/4 3/8 1/2 5/8	Aircraft	
	To 5000 psi	1/2 1	Industrial	

HYDRAULIC PUMPS

PRODUCT	CONTROL	CAPACITY	SYMBOL
Variable displacement pumps	Handwheel Pressure compensator Stem Cylinder	Gpm 10 20 35 5000 psi max.	
 Fixed displacement pumps		Gpm 10 20 35 5000 psi max. Gpm 3.5 7 9.5 To 3000 psi	

FLUID MOTORS

PRODUCT	SIZE	PRESSURE	SYMBOL
Fixed displacement	3 hp 1500 rpm 5 hp 1500 rpm	1000 psi	
Fixed displacement with speed control	3 hp 1500 rpm 5 hp 1500 rpm	1000 psi	
Fixed displacement	8 hp 3000 rpm 17 hp 3000 rpm 24 hp 3000 rpm	2500 psi max.	
 Fixed displacement	55 hp 3000 rpm 128 hp 2500 rpm 177 hp 2000 rpm	5000 psi max.	

Look

Outside ... and Inside

when selecting your

PACKAGE STEAM GENERATOR

ALL STEEL WELDED CONSTRUCTION of casing suitable for outdoor installation.

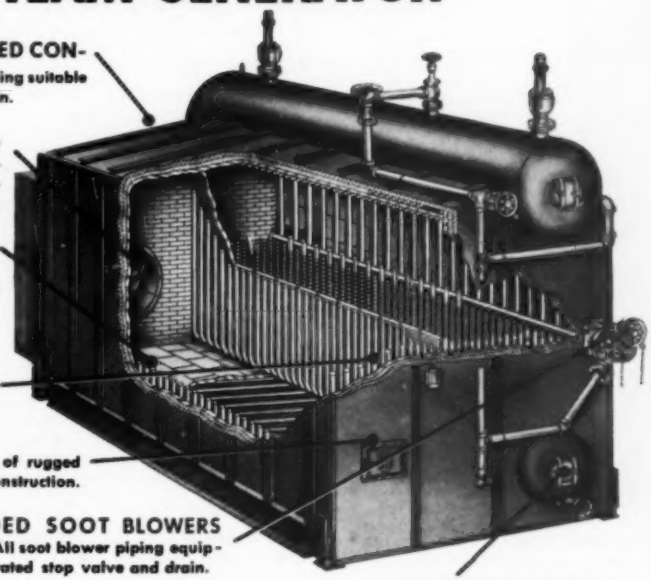
TWO BURNERS on units over 22,500 lb per hr. All burner registers are hinged to permit easy access to diffuser and register louvers.

FURNACE WATER WALLS backed with 2" first quality fire clay tile, 2" block insulation and 2½" rock wool blanket.

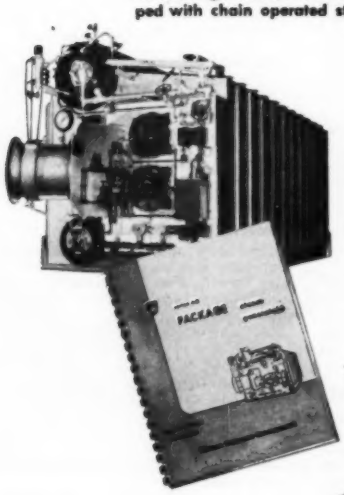
REAR FURNACE WALLS are water cooled for full height of furnace, tie in to boiler circulation without use of headers.

ACCESS DOORS of rugged brick lined cast iron construction.

DOUBLE - ENDED SOOT BLOWERS on the larger units. All soot blower piping equipped with chain operated stop valve and drain.



MANHOLES at both ends of each drum for capacities in excess of 15,000 lb per hr.



Foster Wheeler Package Steam Generators offer you these marks of quality and efficiency, plus water-tube design, large furnace volume and electronic combustion control.

Rugged factory assembled units, they are available in capacities from 10,000 to 30,000 lb per hr, and are easily installed for either inside or outdoor operation.

For further information, write for Catalog PG-51-2, and for article "WATER TUBE PACKAGE STEAM GENERATORS"

FOSTER WHEELER CORPORATION
165 Broadway, New York 6, N. Y.

FOSTER WHEELER

Anti-Corrosion Literature

Latest bulletins and catalogs from leading manufacturers

Each new bulletin item has a key number for your convenience in asking for a free, personal copy. Insert key numbers on return post card found on page 131

Ion Exchanger **700**

Advantages and applications of an alkalinity-reducing ion exchanger which does not require acid for regeneration are presented in data sheet 28X7808. A comparison of water conditioning methods illustrates the unit's simplicity. Allis-Chalmers Manufacturing Co.

Valves & Fittings **701**

Engineers concerned with handling corrosive solutions should find 54-page catalog 47 a valuable source of information. Stainless steel valves and fittings are presented. Of particular value is a section on alloys and their analyses and another section giving specific recommendations of valve materials for use with nearly 400 different corrosive media. Alloy Steel Products Co., Inc.

Copper Alloys **702**

Theory of corrosion and types of corrosive attack are discussed in booklet, "Corrosion Resistance of Copper and Copper Alloys." Included in the engineering data section are charts of corrosion ratings and tables of composition and properties. The American Brass Co.

Dealkalization Process **703**

Increased capacity of anion exchange resins is claimed for a dealkalization process described in 3-page circular. How gas blanketing is prevented during regeneration is described. A complete unit for softening and dealkalizing water is offered. American Water Softener Co.

Amine Treatment **704**

"Plant Stops Return Line Corrosion," technical bulletin 124, should be of interest to engineers troubled with corrosion of steam and condensate lines. Bulletin describes how filming amine treatment eliminates return line corrosion and reduces operating costs. W. H. & L. D. Betz.

Amine Treatment **705**

"Corrosion Protection of Steam and Condensate Return Systems," 4-page folder CP100, tells how amine treatment works to prevent corrosion. Advantages and disadvantages are discussed. The Bird-Archer Co.

Valves **706**

Monel and Mo stainless steel valves for anti-corrosion service are listed in valve catalog. Construction, advantages and sizes are given. Crane Co.

Nickel Alloys **707**

Explanation of corrosion, forms it takes, factors that influence rate of attack and testing methods for determining comparative behavior of metals under corrosive conditions are described in technical bulletin. Includes specific data on resistance of nickel alloys to nearly 500 typical corrosive media. The International Nickel Co., Inc.

Dissolved Gas Analyzers **708**

Presence of dissolved oxygen in feedwater results in corrosion and dissolution of iron throughout the system, according to 4-page folder 148BP. Analyzers for measuring dissolved oxygen and hydrogen are discussed. Instruments measure electrically. Cambridge Instrument Co., Inc.

Pipe & Fittings **709**

Resin-bonded Fiberglas pipe and fittings for anti-corrosion service are described in series of data sheets. Other equipment including tanks and vent hoods also is presented. A test report on chemical resistance of the material to many corrosive media is included. The Chemical Corp.

Amine Treatment **710**

Causes and prevention of corrosion in return lines is discussed in 4-page folder 5103. Clear amine and filming type amine treatments are described. Dearborn Chemical Co.

Organic Treatment **711**

How organic treatment is used to prevent scale and deposits in feed lines, pumps, economizers, heaters and boilers is described in 4-page technical bulletin. Examples are given, and theoretical and practical considerations are discussed. E. F. Drew & Co., Inc.

Rubber Lined Valves **712**

Construction features of rubber lined check and gate valves are described in bulletin. In addition to bonded rubber lining of valve body, all interior working parts are made of alloys suitable for specific corrosive conditions. Darling Valve & Manufacturing Co.

Stainless Steel Valves **713**

Specifications and data for selection of the proper valve for any specific anti-corrosion service are contained in folder 194. Descriptions of stainless steel valves are included. Jenkins Bros.

Rubber Linings **714**

Application of rubber lining to prevent corrosion of tanks, pipes and valves is discussed and illustrated in 4-page folder. In addition, a 2-page reprint tells how rubber lining can stop circulating pipe corrosion. La Favorite Rubber Manufacturing Co.

Controlled Volume Pumps **715**

Descriptions of controlled volume pumps for use with corrosive or highly volatile chemicals of practically any type are included in 24-page bulletin 151. Four pages of quick reference charts show the proper materials of construction for service with over 170 chemicals. Automatic packaged systems including boiler water treatment, pH control and chemical feed systems also are presented. Milton Roy Co.

Water Treatment **716**

"Scale and Corrosion Prevention by Chemical Conditioning of Water" should be of interest to engineers concerned with corrosion problems. Corrosion is dealt with from raw water inlet to and through condensate return lines. National Aluminate Corp.

Process Pumps **717**

Chemical process pumps designed with special emphasis on corrosive and abrasive liquids are described in 8-page bulletin B-1600. Capacities are to 1500 gpm for heads up to 231 ft. Food Machinery and Chemical Corp., Peerless Pump Div.

Water Conditioning **718**

Water conditioning equipment including deaerating heaters, degasifiers, demineralizers, dealkalizers, softeners, filters and storage tanks are listed in 4-page folder. Arranged for quick reference, each item contains illustration and brief discussion. Penfield Manufacturing Co., Inc.

Insulated Piping **719**

Useful data on pipe selection, flexibility and expansion are contained in bulletin 480-6. Condensate return piping and other lines subject to corrosive service may be coated with a special baked-on phenolic resin having excellent corrosion resistance and durability. The Ric-wiL Co.

Valves **720**

Butterfly and slide valves designed for resistance to corrosion or abrasion are described in valve catalog. Rubber lined body and alloy trim suitable for the specific service are available. W. S. Rockwell Co.

Coatings **721**

Chemical and heat resistant coatings, long and short oil type coatings and machinery finishes are described in 16-page catalog 251. Data on each coating includes resistant qualities. Coatings may be applied without removing all the rust. Rust-Oleum Corp.

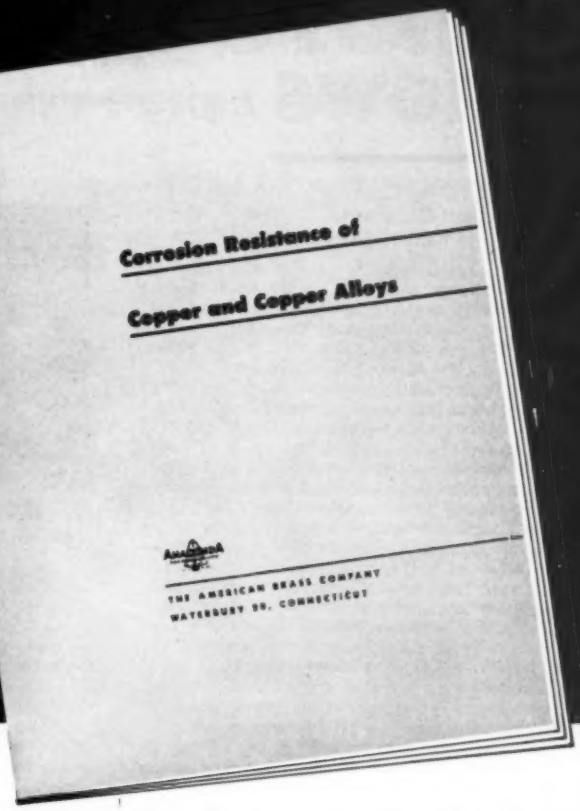
Water Treatment **722**

Advantages and facts concerning a cold process water softening method are contained in 16-page brochure W-212-B5. Cutaway view shows equipment construction, and flow diagram shows auxiliary equipment. Worthington Corp., Water Treatment Section.

New Corrosion Data!

YOU WILL WANT THIS IMPORTANT BOOKLET

containing a new collection of data on corrosion resistance of copper and copper alloys.



For operators and designers of:

Process Equipment
Heat Exchangers
Condensers
Evaporators
Chemical Equipment
Waterworks and Sewage Plants

This new booklet presents in concise, usable form important technical discussions and data on the corrosion resistance of copper and copper alloys. Here are the subjects included:

- **Theory of Corrosion and Types of Corrosive Attack**
- **General Discussion of Corrosion Resistance of Copper Alloys**
- **Corrosion Rating Charts**
- **Typical Industrial Uses of Copper Alloys**
- **Composition, Mechanical and Physical Properties of Copper Alloys**

61310

SEND FOR YOUR FREE COPY TODAY!

The American Brass Co., Waterbury 20, Conn. (In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.)

Please send me my copy of your new booklet, "Corrosion Resistance of Copper and Copper Alloys."

NAME.....

COMPANY.....

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CITY.....ZONE.....STATE.....

where corrosion resistance counts — consider

ANACONDA®

COPPER AND COPPER ALLOYS

Spot news

Short, "boiled-down" paragraphs on the most interesting recent events and developments in American industrial plants

5250 MVA Short Circuits Are Created in New Laboratory

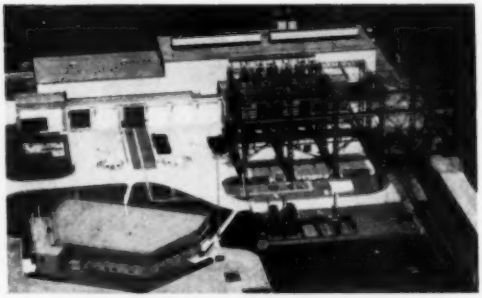
Short circuits of 5,250,000 kva, the most powerful ever produced in a research facility, are created in General Electric Company's new Switchgear Development Laboratory in Philadelphia, Pa. Largest of its kind in the world, the laboratory has become a reality after several years of planning and at a cost of over $10,000,000.

Supplementing engineering and manufacturing facilities, it will be used primarily for development of power circuit interrupters. Although the performance of switchgear products has been outstanding and industry's needs have been met, the phenomenal growth and interconnection of modern power systems necessitates future development, with greater interrupting capacity in both industrial and utility fields. Switchgear integrates the electric power system by uniting its many components into a complete and co-ordinated entirety. Therefore, as these systems grow, it is necessary that switchgear must also grow in quantity, voltage, capacity, and in its ability to control power.

Facilities of the laboratory consist primarily of a main test building, five test cells, a high-voltage test yard, and a control building linked to the main building by an underground tunnel carrying more than 400 miles of wire.

Incoming power is purchased. Two testing generators are employed, each driven by a 4160 v, 3000 hp motor. To absorb the tremendous shocks produced during short-circuit tests, the stator of each generator is supported on spring steel legs. These allow the stator to rotate through a small angle and still remain in alignment with the rotor shaft.

The generators, each nominally rated 15.5 kv, 125,000 kva, 3 phase, 1800 rpm, have been designed when operating individually or in parallel to deliver high values of current to the test cells at voltages up to 15.5 kv. Designed for an unusually low slope decrement, the symmetrical current at the end of five cycles is still approximately 75 per cent of the initial short-circuit value. This is desirable primarily to decrease the need of over-excitation of the generators prior to application of the short circuit. Because of the low slope decrement, high values of current initially and at contact parting time, as well as high values of normal frequency recovery voltage and rate of rise of recovery voltage, tend to yield maximum conditions of test severity.



Air view shows control building in foreground—beyond are the high-voltage test yard and main test building

During test runs the generators produce, on an initial basis, a total of 3,500,000 kva symmetrical or 5,750,000 kva asymmetrical, 3 phase, at their terminals. Available power in each test cell is 3,200,000 kva symmetrical and 5,250,000 kva asymmetrical at the first ¼ cycle after short circuit, with 75 per cent of this at the end of 5 cycles.

Two 100,000 kva transformers with unusually low reactance supply up to 400 kv to the high-voltage yard—the maximum depending on the particular connections of generators and transformers as well as translation of results by the type of test method being used. Three 24,000 kva transformers supply currents as high as 500,000 amp symmetrical at 600 v or 400,000 amp at 1200 v to test cell No. 5.

Control room affords protected view of all test cells and high-voltage test yard. Master control is for generators as well as apparatus under test. Lab employees are shown studying oscillograph records of test

Exchange Capacity of Chloride Dealkalization System is Increased

An important discovery concerning regeneration of chloride dealkalization systems has been made by engineers of American Water Softener Co. This process reduces alkalinity of water by anion exchange material regenerated with the chloride ion of a salt. Previous data for standard anion exchange materials for dealkalization have indicated unusually low exchange capacities. Consequently cost of exchanger and equipment to contain it has been high.

(Continued on page 114)

Here's the INSIDE STORY

of Dayton V-Belt's Design Leadership!

All-weather, rubber impregnated cover, made of costly, "Hi-Twist" fabric, for better flexing, and longer wear. Proper bias angle maintained at all times, for easy flexing.
Exclusive Dayton 327-V blend of natural and synthetic rubbers. Blended for tension—stretches easily and returns to original position instantly. Eliminates distortion and heat build-up.
Every cord has thousands of continuous filaments of high-tenacity rayon! And the complete surface of each cord is fully rubber coated by Dayton's new Thoro-Bonding process. Result: high resistance to fatigue . . . great flexibility . . . high tensile strength!
Special compound (812-V) for compression section of belt only. Compresses with minimum "prodding"* of cords during flexing—maintains crosswise rigidity.
*The upward thrust of the compression section against the cords.

Dayton made the *first* successful V-Belt . . . was first to bond rubber successfully to rayon cords in belts . . . made the first oil-proof belts. Year after year such pioneering developments give Dayton V-Belts *design leadership* in their field. This is your assurance of greater V-belt efficiency, longer life, and lower over-all V-belt costs.

No wonder the hundreds of millions of Dayton V-Belts in use are writing new records of cost-cutting endurance!

For the Inside Story on how the complete line of Dayton V-Belts can cut costs in your plant, call your Dayton Distributor. You'll find his name listed under "Belting" in your telephone directory.

©D.R. 1952

DAYTON RUBBER COMPANY • DAYTON 1, OHIO

V-Belts by **Dayton Rubber**

Since 1905

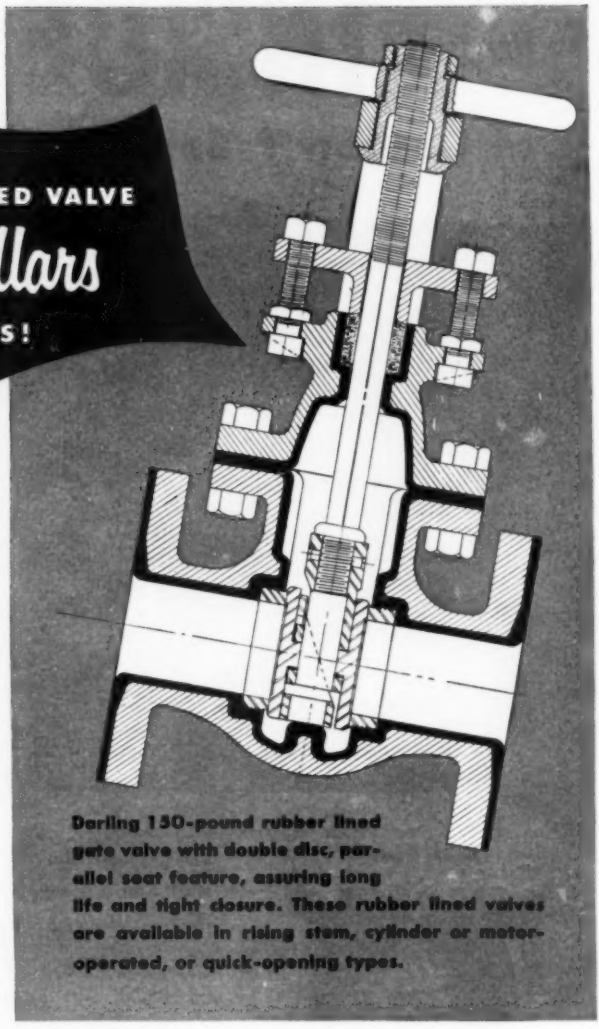
WORLD'S LARGEST MANUFACTURER OF V-BELTS

HOW THIS RUBBER LINED VALVE

stretches dollars

IN CORROSIVE SERVICES!

it's a DARLING fully revolving double disc iron body gate valve



Darling 150-pound rubber lined gate valve with double disc, parallel seat feature, assuring long life and tight closure. These rubber lined valves are available in rising stem, cylinder or motor-operated, or quick-opening types.

IN many corrosive services up to 180° F, Darling hard rubber lined iron body gate valves are taking the place of costly special alloy valves . . . saving plenty of dollars!

And when it comes to year-in, year-out behavior, they can't be beat! A proved bonding technique permanently prevents separation of the hard rubber lining from the valve body. All interior working parts are made of alloys suitable for the corrosive conditions involved.

Equally important, these valves feature Darling's fully revolving double disc parallel seat principle. This, combined with the equalizing wedges, means easy, *tight* closure even if seats are not parallel due to line stresses. It means *uniform* distribution of wear for prolonged life with minimum maintenance cost.

SEND FOR DATA. A bulletin covering Darling rubber lined *gate* and *check* valves is yours for the asking. In addition, Darling parallel seat revolving disc gate valves are available in a wide range of sizes and constructions for all kinds of normal and unusual service, and for pressures up to 1500 pounds. We'll gladly furnish specific recommendations on the proper valves for your particular service.

DARLING VALVE & MANUFACTURING CO.

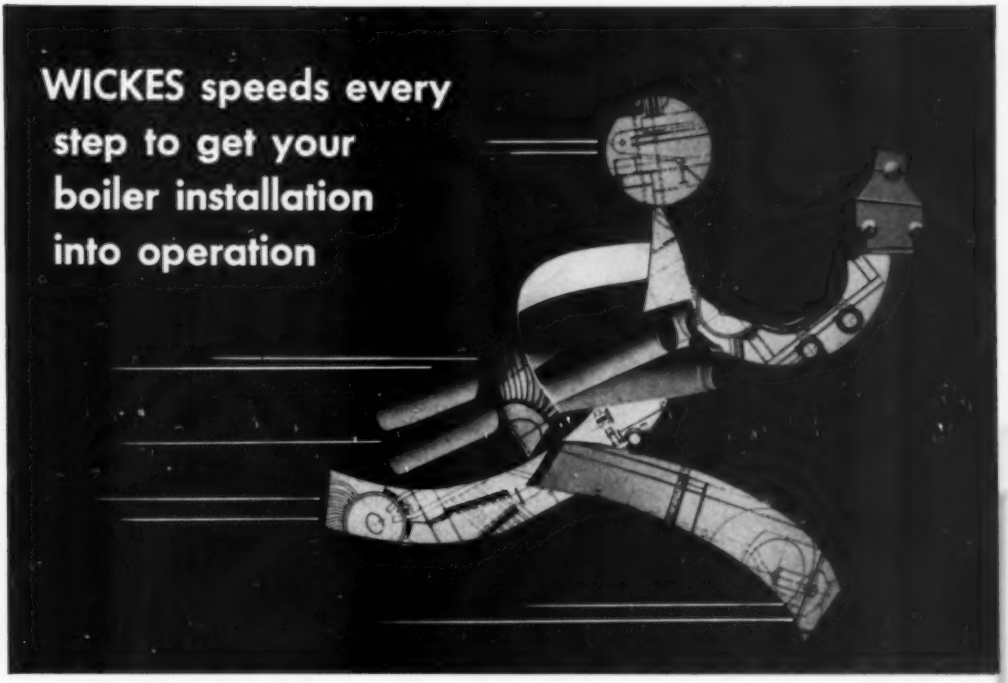
Williamsport 9, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

DARLING VALVES

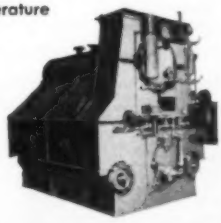
FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

WICKES speeds every step to get your boiler installation into operation



From the moment you place your order for a Wickes boiler, Wickes engineers and production men swing into action. They know that when you want a new steam generator, you want it fast and they rush production to get it to you. Wickes does the whole job, too—from the time the first drawings are made right up to the day you raise steam pressure. They build the boiler and they handle every last detail of installation. Then Wickes service takes over and continues for the life of the boiler. Wickes sales engineers and maintenance men in most principal cities are ready to serve you day or night.

Wickes can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi.—all types of multiple drum boilers adaptable to any standard method of firing. Wickes boilers operate at a high degree of efficiency and owners' records show modest maintenance costs. Write today for descriptive literature or consult your nearest Wickes representative.



WICKES

T40

THE WICKES BOILER COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 • SALES OFFICES: Atlanta • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Detroit • Greensboro, N. C. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Pittsburgh • Portland, Ore. • Saginaw • San Francisco • Springfield, Ill. • Tampa, Fla. • Tulsa • Washington, D. C.

Combustioneer AUTOMATIC COAL STOKERS

What do you pay for coal, at today's high prices? What's the labor cost for firing your boilers or furnaces? Those costs are easy to discover. Shocking too! But you can slash them . . . up to 30% on fuel, 50% on firing . . . this EASY way!

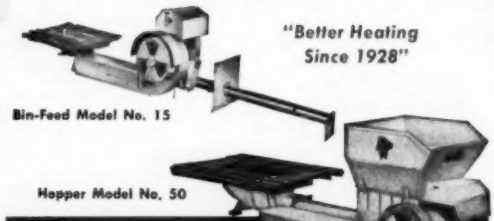
Combustioneer *Automatic Coal Stokers* will deliver more heat per dollar, in YOUR plant! The **Combustioneer** patented transmission and exclusive Automatic Respirator assure maximum thermal efficiency . . . permit the burning of *cheaper* coal, and *less* of it. The fire-bed is always open, porous, free-burning!

Hopper and Bin-Feed Models. Capacities ranging from 9 to 1100 lbs. per hour to serve your particular heating requirements. For maximum labor saving, a Bin-Feed Model, using a pick-up worm, will take coal from 16½ ft. *under the pile.* All **Combustioneer** models ruggedly built, for longer, harder, trouble-free service.

Free . . . Heating Facts in YOUR Plant

A FREE survey will tell you what your costs can be . . . how and how much you can SAVE . . . with **Combustioneer** Automatic Coal Stokers. Write for the free survey and complete details . . . no obligation. **Combustioneer** DIVISION, THE STEEL PRODUCTS ENGINEERING COMPANY, 1236 W. COLUMBIA ST., SPRINGFIELD, OHIO.

"Better Heating Since 1928"



Bin-Feed Model No. 15

Hopper Model No. 50

Combustioneer

GAS BURNERS • HIGH AND LOW PRESSURE OIL BURNERS
STOKERS • COAL-GAS-OIL FURNACES • HUMIDIFIERS

Spot news

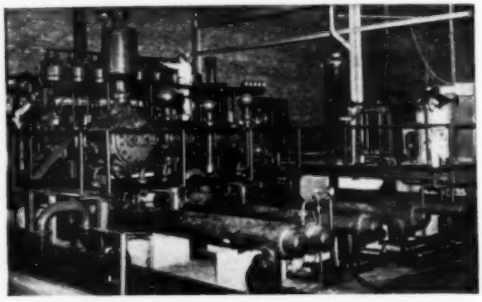
(Continued from page 110)

It was found that apparent low exchange capacity is not a limitation of the exchange material, but a physical consequence of attempting to dissolve excessive amounts of bicarbonate ion contained in the regenerant solution. Substantial gas blanketing of the exchange resins was experienced when using straight chloride regeneration. By addition of small controlled amounts of sodium hydroxide to the regenerant, thus raising the pH value, tendency to blanket exchange resins is eliminated. This discovery, incorporated in the company's dealkalization process, is said to reduce initial and operating costs more than 25 per cent.

New Plant Uses Pipeline To Supply Oxygen Gas

Anticipating the expanding needs of the Southwest's industrial development, the Houston Oxygen Co., Houston, Texas, recently placed in operation a new million-dollar plant for the production of pure liquid oxygen and nitrogen, and pure oxygen, nitrogen and argon gases.

A 3 in. pipeline, operating at 100 psi, is being used to supply many large plants in the area with dry oxygen gas. For users not served by the pipeline, a central storage system is employed. Banks of permanently placed tubes for storage of dry oxygen gas, or liquid oxygen storage tanks plus a converter unit to generate dry oxygen as required, are refilled by specially built tank trucks carrying liquid oxygen at atmospheric pressure. One of these, a trailer unit, will carry



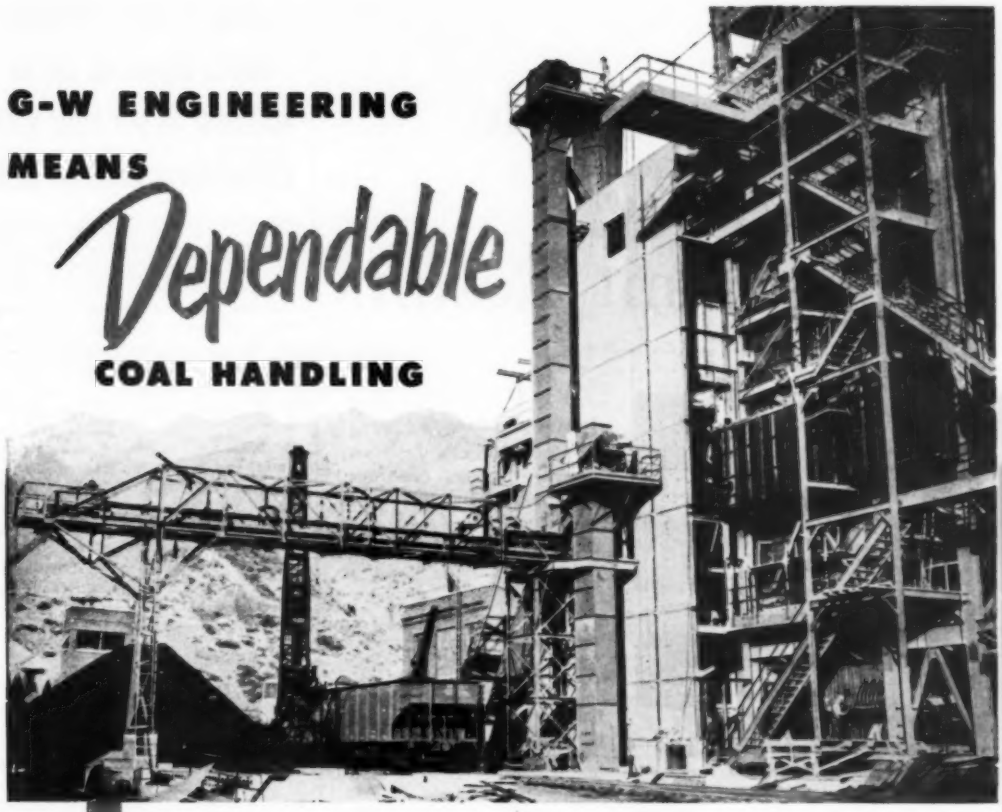
1100 hp Clark natural gas engine and 5 stage battery of high pressure air compressors. Heat exchangers for 5 compressor stages are shown in foreground

the equivalent of 280,000 cu ft of oxygen gas. This type of service is said to eliminate lost production due to handling individual cylinders and switching regulators and hoses from empty to full tanks.

A 1100 hp Clark natural gas engine and 5 stage compressor is used in production of the gases. Air taken from atmosphere is progressively compressed to 2350 psi. It then undergoes a series of drying, cooling and expansion processes, and eventually passes to a rectification column where component elements are separated and purified.

—End

G-W ENGINEERING MEANS *Dependable* COAL HANDLING



The Gifford-Wood coal handling system at the Orem steam electric station of Utah Power & Light Company is designed to handle run-of-mine bituminous coal at 100 tons per hour from dual track hoppers to ground storage, or to overhead storage bins for automatic delivery to boilers. Coal handling is automatic . . . economical . . . completely dependable. The installation, protected by electrical interlocks, is a perfect example of the rugged design and flexibility that can be built into the operation of a well designed power plant.

This complete coal preparation and handling system is but one of the many solutions to dependable low cost coal handling . . . Solutions designed by G-W engineers . . . based upon over 135 years of experience accumulated by G-W in the methods of design, engineering and installation of all types of materials handling systems. Bulletin No. 300 contains the complete story. Send for your copy now, it may well lead to lowered costs tomorrow.

GIFFORD-WOOD CO.

Since 1814
HUDSON, NEW YORK

NEW YORK 17, N. Y. — 420 Lexington Ave.
ST. LOUIS 1, MO. — Railway Exchange Bldg.
CHICAGO 6, ILL. — 565 W. Washington St.

7633

When You Think of Materials Handling . . . Think of Gifford-Wood

Hays Guide to Boiler Plant Results

increased efficiency

"Operating efficiency has been as high as 82%—much of the credit going to the accuracy of (Hays) automatically controlled combustion."

SHERWIN WILLIAMS, Chicago Plant

low maintenance

"we find that due to the (Hays) properly controlled combustion, our maintenance on both stokers and boilers has been considerably decreased."

AMERICAN TOBACCO COMPANY

fuel savings

"we estimated that . . . we would be able to pay for the new equipment (Hays Combustion Control) out of the fuel savings in three years. Since then, the records show that the amortization of the original investment has been accelerated."

RAYBESTOS-MANHATTAN, INC.

rapid response to wide load swings

"we have made test runs using the Hays system, bringing the load rapidly up from 8,000 to 80,000 lbs per hour with excellent results. Fuel-air ratio was held at the desired value and CO_2 at 15%."

BEMIS BROTHERS BAG CO.

HAYS COMBUSTION CONTROL GETS RESULTS . . . *Proof of this statement is available in the form of case histories on the boiler plant experience of 9 leading companies. These "result stories" cover small, medium, and large boilers —burning all types of fuel, including alternate fuels—with different load characteristics—and different uses for steam.*

Send us a brief statement of your specific conditions and specifications. You'll receive the case histories which fit your needs and a 48 page booklet on "Boiler Plant Instrumentation".

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders

THE hays CORPORATION

MICHIGAN CITY 2, INDIANA

Large Power Producer Meets Demands up to 400,000 lb per hour with Evaporation Rate of 12.8

"During the many years we have been generating power at Scovill Manufacturing Company, Waterbury, Conn.," says Leo Niekerk, Power Plant Chief Engineer, "we have evolved a general philosophy for power plant operation: buy the best equipment available, then operate and maintain it in the most intelligent way possible. We have two power houses—the West Power House containing one 500 kw vertical turbine, one 3,000 kw condensing turbine generator, and two 600 hp oil-fired 150 psi boilers on standby; and the East Power House containing three 3500 kw condensing turbines, one 5,000 kw topping turbine, six 600 hp stoker-fired 250 psi boilers and, handling most of the load, two 660 psi oil or pulverized coal-fired steam generating units rated at 225,000 lb/hr and 150,000 lb/hr."

fuel handling

"Coal from railroad cars is transferred to overhead bunkers by a conveyor system. Fly ash from dust collectors is removed by conveyor ash handling system and discharged through an outside silo. Oil is stored in two 150,000 gal. tanks and fed by gravity to the fuel oil pumps in the basement."

combustion control

"When we installed our Boiler #1 in 1940 we selected Hays Combustion Control. We were so pleased with its operation during the next six years that when we installed Boiler #2 in 1946 we again specified Hays Combustion Control. Each boiler has its own Hays panel containing a complete complement of modern boiler room instruments and controls. Currently we are meeting steam demands up to 400,000 lb per hour (with load swings as high as 60,000 to 70,000 lb per hour) while achieving an evaporation rate of 12.8, a fuel cost per kw of $.0049, and a cost per thousand pounds of steam of $.706. No small part of the credit for the versatility and efficiency of our operations should go to the Hays Combustion Control System. Maintenance expense on the control system has been negligible.

The above story is a condensation of a completely illustrated case history on the power plant operation of Scovill Manufacturing Company. Write for Bulletin R-8, available free from The Hays Corporation, Michigan City, Ind.

NOW STANDARDIZED

3 Precision Controls for All Speed Problems

Here's governor standardization that "pays off". Now you can economically solve all speed-control problems with only three basic governors.

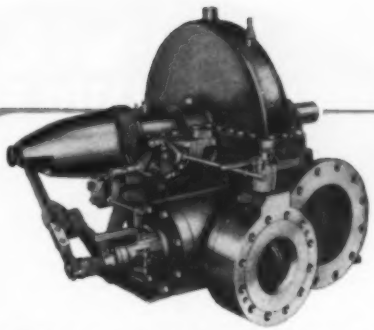
Costly special engineering is eliminated. Advanced design gives an unusual degree of flexibility... with precise speed control for all steam conditions. Results? Initial costs are lower... shipments are quicker... spare-parts inventory is reduced.

Designs for three basic classes of steam conditions, three wheel sizes, and three types of governors provide, in effect, twenty-seven standard variations to cover a wide range of applications. All oil-governed, direct-connected Type E units include the standard reservoir-type base, as illustrated. What's more, Type E governors can meet a great number of special requirements with optional accessories. This standardization results directly from Westinghouse's wide experience in all industry.

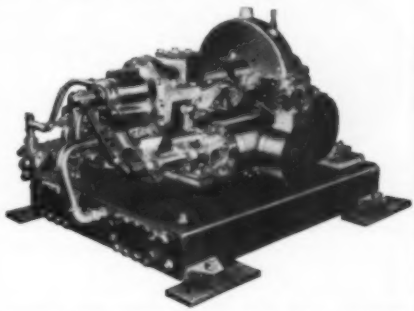
Other outstanding maintenance-saving features on the Type E turbine are Dual Protection... Weather Protection... Centerline Support... and a Rugged Governor Housing. Ratings are available from 5 to 1,500 hp.

For complete information ask your nearby Westinghouse representative for Type E Turbine Book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

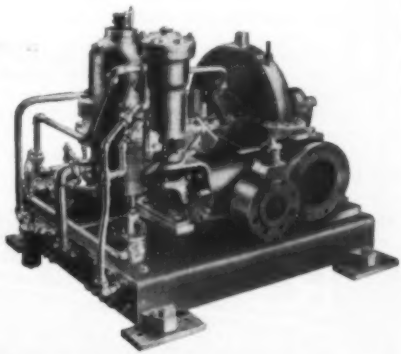
YOU CAN BE SURE.. IF IT'S
Westinghouse
TYPE E Turbines



Shaft-Type Governor. For narrow speed-range applications, this governor automatically positions the steam admission valve to control turbine speed within close limits—*6 to 8% speed regulation.*



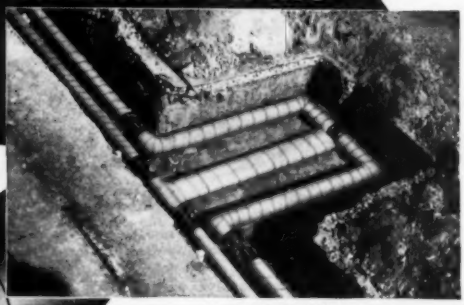
Hydraulic-Orifice Governor. For wide speed-range applications such as drives for fans, blowers, and compressors —*3-to-1 speed-adjustment range; 6% speed regulation.*



Vertical Oil-Relay Governor. For narrow-range precision-control applications such as drives for generators, pumps, blowers and compressors—*33⅓% speed-adjustment range; 4% speed regulation.*

J-50527

RIC-WIL
QUALITY INSULATED PIPING



— — — MEANS
Higher EFFICIENCY
Longer LIFE
Lower INSTALLATION COSTS

There is no stronger proof of Ric-wil quality and dependability than the specification time after time of Ric-wil Systems for heating and process distribution piping in major defense projects, industrial plants, and utility central heating systems.

Engineers like the way Ric-wil Insulated Piping can be quickly adapted and laid out to meet any design or operating conditions. Contractors like the savings in installation possible with these 21-ft. prefabricated units, their easy handling and simple coupling features. Owners have the satisfaction of knowing that a Ric-wil distribution system will provide high thermal efficiency, maximum protection, and long service life.

Condensate return piping and other lines subject to corrosive service may be coated with Ricwilite, a baked-on phenolic resin having outstanding corrosion resistance and durability.

Let a thoroughly experienced representative show you the installation and operating economies possible with Ric-wil on your next insulated piping project.

RIC-WIL TYPE "B" COUPLER

Provides a watertight conduit joint with synthetic rubber gaskets. No conduit welding required, expediting joint closures.

RIC-WIL
INSULATED PIPING SYSTEMS
UNDERGROUND OR OVERHEAD

WRITE FOR . . .
Your copy of Section 480-6. Contains valuable data on pipe selection, flexibility, and expansion.

THE RIC-WIL COMPANY, CLEVELAND, OHIO
AGENTS IN PRINCIPAL CITIES
LEADERS IN INSULATED PIPING PROTECTION

PREFABRICATED INSULATED PIPING

SECTIONAL CONDUIT SYSTEMS

PREFABRICATED MANHOLES

UTILIDOR TYPE CONDUITS

News of men and companies

SOCIETIES

Instrument Society of America—At the annual meeting of the New York Section the following men were elected to office and assumed their duties for the coming year:

President, C. S. Beard,
Ebasco Services Inc.
Vice-President, H. C. Mittendorf,
Combustion Engineering-Superheater, Inc.
Secretary, R. A. Hutcheon,
Consolidated Edison Co.
Treasurer, U. P. Rothermal,
Republic Flow Meters Co.
Journal correspondent, J. R. Walters,
Energy Controls Co.

The executive committee for the coming year is:

F. R. Manning,
Weston Electrical Instrument Co.
C. E. Haggarty,
N.Y.C. Dept. of Public Works
C. H. Gaites,
The Bristol Co.
S. H. Morrison, Helicoid Gage Div.,
American Chain & Cable Co., Inc.
F. B. Leslie,
The Permutit Co.
R. E. Marion,
Ford, Bacon & Davis, Inc.
W. W. Matloch,
Brown Instrument Co.
R. J. Rimbach,
Instruments Publishing Co.
T. L. R. Williamson,
Burns & Roe

Air Pollution & Smoke Prevention Association of America—Shown here are the newly elected president and two new members of the board of directors. They were elected at the 45th annual meeting in Cleveland. From the

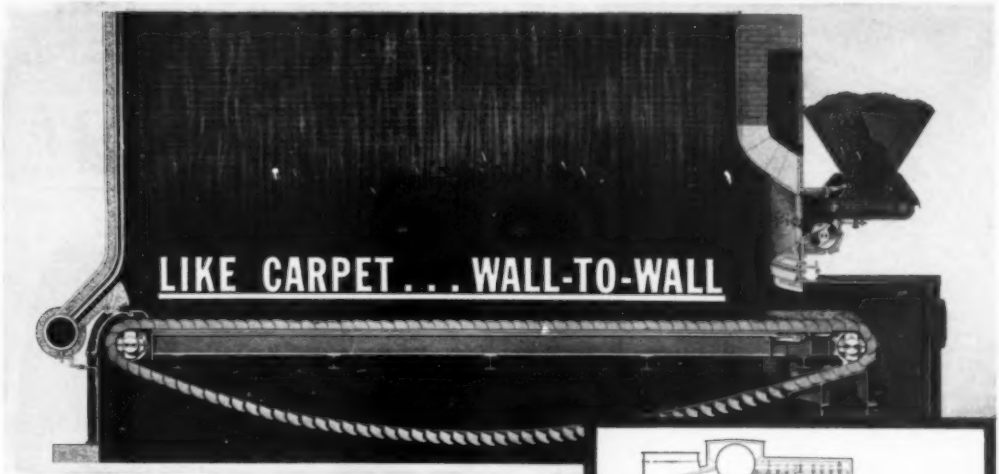
left: R. E. Nicholls, chief smoke inspector, Windsor, Ontario, a new director; J. H. Carter, Commissioner of Smoke Regulation, St. Louis, the new president; and W. H. Carter, technical engineer of power plants for Detroit Edison Co. Other new directors are H. K. Kugel, chief engineer of the Dept. of Smoke Regulation and Boiler Inspection, Washington, D. C., H. E. Aldrich, mgr of American Boiler and Affiliated Industries, and G. A. Davidson, v-p of Standard Oil Company of California.

(Continued on page 121)

CUTTING A BOILER IN TWO

to show why we dare call this stoker the

PERFECT SPREAD

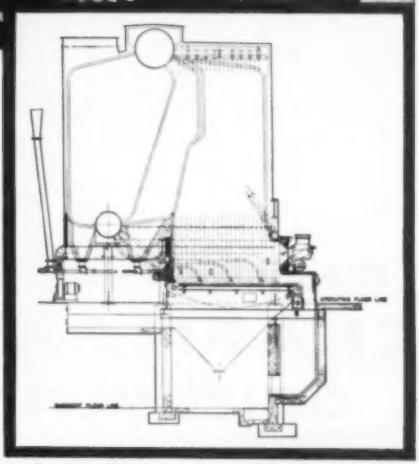


It's simple . . . it's economical and it
WON'T CLOG ON WET COAL

WHETHER THE COAL is bone dry or sopping wet, every AE conveyor feeder can deliver from 50 to 7,500 lbs. of coal per hour. The high traction principle employed – and its exclusive spiral overthrow rotor – deliver absolute uniformity of spread over the whole grate area, dependably, continually and without troublesome coal agitators.

Perfect Spread Stokers are built in a wide range of sizes, capacities and grate types . . . but *all* of them are equipped with American Engineering's exclusive conveyor feeder and rotor. This is one feeder that *won't clog on wet coal* . . . one whose true, continuous feeding is universally acknowledged as unexcelled.

If you need extra steam capacity, wish to replace obsolete equipment or abandon hand firing, mail coupon for full facts about Perfect Spread Stokers.



The above installation, designed to burn Ohio coal 11,600 B.T.U.s "as fired", 12.7% ash, 4.4% sul., with 2,000° F. – A.S.T.

AMERICAN ENGINEERING
COMPANY
PHILADELPHIA 25, PENNA.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

American Engineering Company
2406 Aramingo Ave., Philadelphia, Penna.

Gentlemen:- We are interested in getting top efficiency from both low and high ash coals. Please send us full information about Perfect Spread Stokers.

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

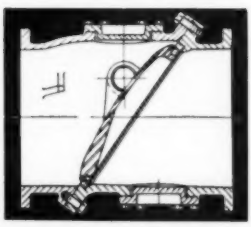
Here's the One "TILT" that Pays Off On the Level!...

the TILTING DISC in CHAPMAN'S CHECK VALVE

Yes, this is on the level . . . Chapman's Tilting Disc design offers you savings in head loss 65% to 85% over regular swing-type check valves.

For this Tilting Disc rides the flow . . . cushions itself to a quick, *quiet* closure right at the instant when there's no velocity in the line. There's no slamming, under usual pipeline arrangements. So there's no jarring of the line, no opening of the joints, no wear of moving parts worth mentioning. And seating is *drop-tight.*

Certified engineering test-results are charted in Catalog No. 30. Take a look at these tests . . . and then figure what Chapman Tilting Disc Check Valves can save for *you.* Send for your copy now.



Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

THE CHAPMAN VALVE MFG. CO., INDIAN ORCHARD, MASSACHUSETTS

News
of men and companies

(Continued from page 118)

HONORS

Pacific Gas and Electric Co.—Received the Charles A. Coffin award, the electrical industry's top honor, for outstanding achievement during 1951. Selection was based on the company's desire and ability to bring adequate electric power to its area through a billion-dollar construction program.

Irving Subway Grating Co.—W. E. Irving, founder and president of the company, was presented with the honorary degree of doctor of engineering by Rensselaer Polytechnic Institute. He also is celebrating the golden anniversary of the founding of his company.

Westinghouse Electric Corp.—T. Fort, v-p in charge of the apparatus div, received an honorary doctor of laws degree from the New Mexico College of Agriculture and Mechanic Arts.

EXPANSIONS

Johns-Manville Corp.—A major expansion of the plant at Watson, Calif. for the production of industrial insulations, is announced. It is expected that construction of the 100,000 sq ft building will be completed in the early fall of 1953.

U. S. Electrical Motors Inc.—Engineering plans are practically complete so that ground breaking can soon take place for the several million dollar defense div plant to be erected on Santa Ana Freeway between Anaheim and Buena Park, Calif.

Westinghouse Electric Corp.—A new multi-million dollar plant for the manufacture of watthour electric meters will be built in Raleigh, N. C. Also announces plans to build a multi-million dollar industrial and commercial lighting equipment plant in Vicksburg, Miss.

APPOINTMENTS

The Fairbanks Co.—Election of E. T. Flanagan to position of v-p in charge of sales is announced.

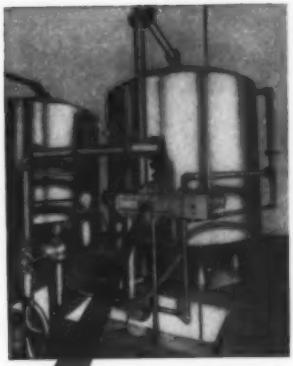
E. T. Flanagan **H. R. Fosnot**

Graver Water Conditioning Co.—Announces appointment of H. R. Fosnot as asst genl sales mgr, and L. Limon as mgr, sales engineering dept.

(Continued on page 122)

PROCESSES FOR REMOVAL OF WATER IMPURITIES

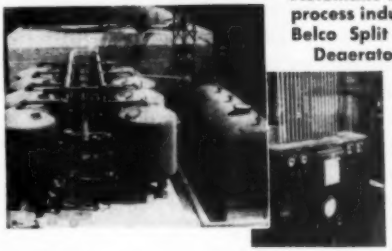
BELCO combines the best in design with automatic control



BELCO CAMOMATIC VALVE

The Belco Camomatic Valve replaces the seven individual valves required for normal softener operation. When instruments indicate, or when a predetermined amount of raw water has been used the softening cycle is set in operation, automatically. The Camomatic valve is easily adapted to pressure filtration and other process control. These valves are being used in some of the country's finest plants.

Automatic installation in large process industry. Panel controls Belco Split Stream Plant and Deaerator, automatically.



Belco has built the largest automatic silica removal demineralizer plant in the world. Your needs will be met with unmatched engineering knowledge and with equipment designed to do your job.

BELCO ATOMIZING VALVE

★ We invite your consultations regarding all water conditioning requirements. Get acquainted with our organization for authoritative assistance and close cooperation. Write for late descriptive bulletins.

BELCO HIGH PRESSURE STEAM DEAERATOR

Belco

Belco Industrial Equipment Division, Inc.

PATERSON 3, NEW JERSEY

COMPACT

within arms' reach

MORE STEAM
in LESS SPACE... at LESS COST!

The Clayton Forced Recirculation Steam Generator produces more steam per pound of weight and per cubic foot of space occupied than any boiler known... and at less cost. Fast steaming, automatic and safe, the Clayton Generator sets a new standard of efficiency for the production of processing steam. It is the only steam generator with a cost curve that parallels the load demand curve through all stages of operation. Each unit... 15 to 100 h. p.... is complete, ready to connect and operate upon delivery. No burners, pumps, instruments or accessories to buy.

THIS COUPON BRINGS PROOF TO YOUR DESK

An animated, colored flow chart shows you how and why the Clayton Forced Recirculation principle can cut your steam costs.

IP-7

CLAYTON MANUFACTURING COMPANY
Box 550, EL MONTE, CALIFORNIA

Send name of nearest distributor and arrange desk demonstration of Clayton Forced Recirculation principle. Send catalog.

NAME_____

FIRM_____

ADDRESS_____ STATE_____

CITY_____

Clayton

MANUFACTURING COMPANY
Box 550, EL MONTE, CALIFORNIA

News
of men and companies

(Continued from page 121)

Allis-Chalmers Manufacturing Co.—J. J. Kleczka is assigned to the Norwood Works as asst engineer. W. F. Heinrich is named asst foreman in the production engineering section at the Hawley Works.

American Locomotive Co.—Appointments of D. D. Frank as director of information and D. J. Duffin as promotion mgr are announced.

BullDog Electric Products Co.—Appoints C. S. Mann and D. S. Mezak as field engineers in Conn. and Mich. respectively. Mann will make his hqtrs at 128 Pearl St., Middletown, Conn. Mezak will make his hqtrs at 939 Fairbanks, Kalamazoo.

The Cleveland Chain & Mfg. Co.—D. J. Owens is appointed sales mgr and assumes direction of the company's entire sales program.

General Electric Co.—K. R. Van Tassel is appointed genl mgr of the operating dept of the Knolls Atomic Power Laboratory. He succeeds W. H. Milton, Jr., who is resigning as of August 1. D. B. Lawton, former asst mgr of mfg, transformer operations, is named mgr of the newly-planned transformer mfg plant at Rome, Ga.

Johnston Pump Co.—At a special meeting of the board of directors, T. W. Simmons, Jr. was elected president and genl mgr.

R. M. Bode **T. W. Simmons, Jr.**

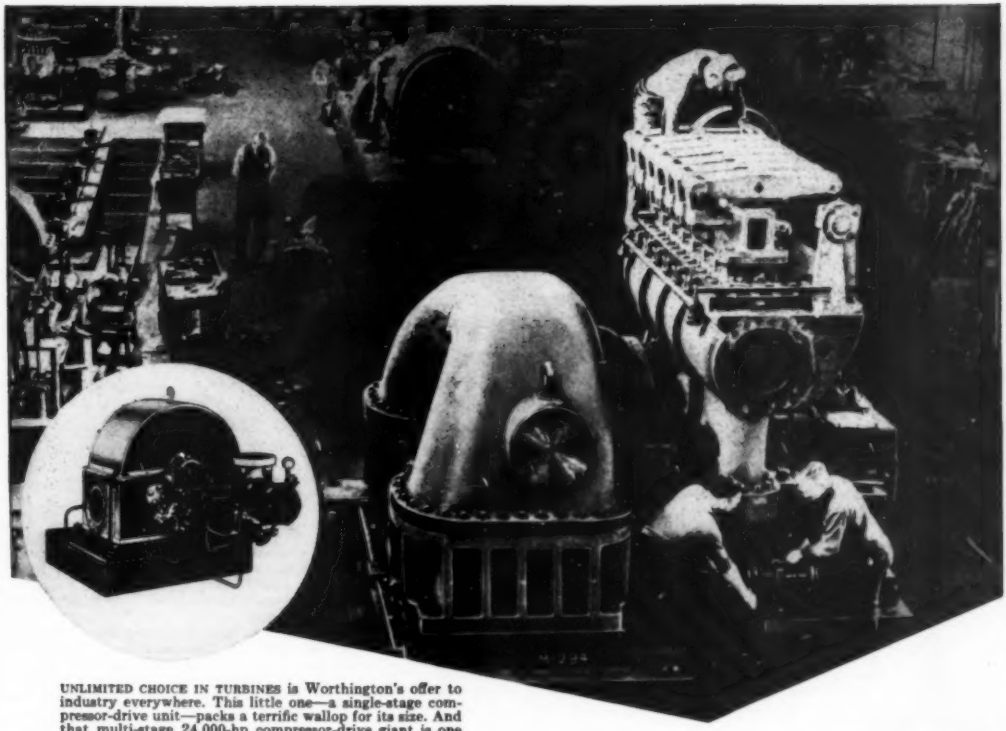
Ladish Co.—Simultaneously with the introduction of a new line of forged steel valves, the appointment of R. M. Bode to an executive sales position in the valve and fittings div is announced.

ANNIVERSARIES

Manning, Maxwell & Moore, Inc.—Recently held a two-day centennial celebration at its Stratford, Conn. plant, in honor of the one hundredth anniversary of its Ashcroft Pressure Gauge line of products.

The Kirk & Blum Manufacturing Co.—Almost 1200 years of service were commemorated at a dinner honoring 40 employees who have been associated with the firm from 25 to 44 years. The fact that the company had just passed its 45th anniversary also was noted.

(Continued on page 124)



UNLIMITED CHOICE IN TURBINES is Worthington's offer to industry everywhere. This little one—a single-stage compressor-drive unit—packs a terrific wallop for its size. And that multi-stage 24,000-hp compressor-drive giant is one of the largest ever built for this type of service.

Single-stage midgets to multi-stage giants

Whether your turbine requirements call for the biggest or the smallest—straight condensing . . . straight non-condensing . . . extraction . . . mixed pressure extraction . . . low pressure . . . high back pressure . . . for mechanical or generator drive . . . with governors for constant or variable speed—*Worthington has an answer.*

Each Worthington turbine is designed to make the steam do *more* work, so you save power and money throughout its long life.

Learn more about Worthington turbines. Get the facts on why *there's more worth in Worthington* by writing to Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.

T.2.2

A GREAT TEAM IN STEAM

WORTHINGTON
Steam Turbines

Controlled Pressure

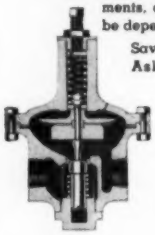
for efficient operation

Clark Pressure Reducing and Regulating Valves

are precision-made for positive pressure control on air, gas or steam lines.

Where different types of equipment, with varying pressure requirements, are operated from a common line, Clark Regulating Valves can be depended on to deliver automatically the "just right" pressure to each.

Save on fuel, maintenance and protect expensive equipment. Ask your Clark representative to specify the right Clark valves for your needs . . . or write us direct.

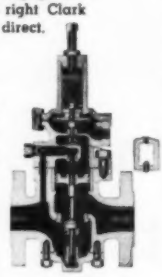


TYPE KRV

Pressure Reducing Valve. Diaphragm Operated-Single Seated Valve. Sizes ½" to 1½" for initial pressures up to 250 P.S.I. Reduced pressures to 85 P.S.I.

TYPE CRV

Pressure Reducing Valve. Integral pilot controlled, piston operated. For pressure control from "dead end" to full capacity. Sizes ½" to 6".



TYPE ORV

Pressure Reducing Valve. ⅜" and ½" Single Seated, Spring Loaded, Diaphragm Actuated. For initial pressures to 250 P.S.I. Reduced pressures to 200 P.S.I.

QUICK-CLEANING STRAINERS

Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3" I.P.S. For pressures to 250 P.S.I.

THE CLARK MANUFACTURING COMPANY

1830 East 38th St. • Cleveland 14, Ohio

Clark

THE HOME OF DUO STEP LEVERAGE

The complete line of dependable fluid controls

News

of men and companies

(Continued from page 122)

SALES OFFICES

Quaker Rubber Corp.—Establishes branch warehouse and sales office at 430 South Mill St., Lockland 15, Cincinnati, Ohio, under supervision of W. W. Hutchinson.

ANNOUNCEMENTS

Quaker Rubber Corp.—The new three-quarter million dollar compounding and mixing building is operating.

Willard Storage Battery Co.—Completed a new $3 million factory on Emmaus Highway, Allentown, Pa.

Yarnall-Waring Co.—More than 850 guests at a recent "Open House" toured the expanded plant.

NEW REPRESENTATIVES

Cleaver-Brooks Co.—Announces appointment of the Mason Equipment Co., 2281 Wildwood Blvd., Toledo, Ohio, as manufacturer's representative.

Childers Manufacturing Co.—The W. M. Acker Organization, Inc., 3167 Fulton Road, is appointed to handle the Cleveland territory. Jobe & Co., 344 East 33rd St., is handling Baltimore.

Conoflow Corp.—Appoints Bruce Greaves Co. as representatives in the St. Louis territory.

Nordberg Manufacturing Co.—Appointment of Olson Equipment Co., 2930 Blaisdell Ave., Minneapolis, as distributor in Minnesota and northwestern Wisconsin is announced.

Owens-Illinois Glass Co.—Allied Services, Inc., Charleston, West Va. is appointed distributor-applicator for Kaylo Heat Insulation.

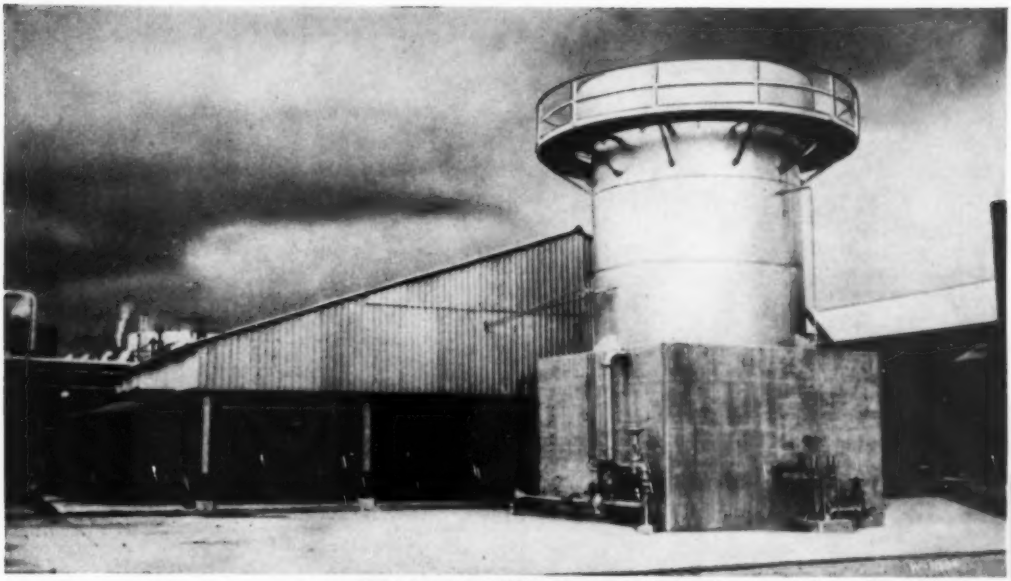
APPOINTMENTS

National Electric Products Corp.—Announcement is made that J. L. Marsh joined the organization as regional specialist on all products. He has hqtrs in the Chicago office.

J. L. Marsh **O. G. Wenzel**

Nordberg Manufacturing Co.—Appointment of O. G. Wenzel as sales engineer in the New York office of the Heavy Machinery Div. is announced.

(Continued on page 127)



SPECIALLY DESIGNED 500 GPM WORTHINGTON TREATING SYSTEM at the new Pemex natural gas refinery in Poza Rica, Mexico. System includes cold-process slurry-type softener followed by acid feed, filtration and zeolite treatment. Engineered by Arthur G. McKee Company.

Specially Designed for Intermittent Service

Softening system for boiler feed water built for short-period operation, long shutdowns

Water conditioning requirements are especially tough at the new Pemex natural gas refinery in Poza Rica, Mexico.

Their need for variable-rate, continuous-service softener operation is complicated by the intermittent boiler feed-water storage demands.

Pemex's conditioning requirements have been met by a specially built Worthington system, so designed that the slurry bed is not lost during "off-service" periods. The bed resumes its normal suspended position at the instant service is resumed. This avoids the irregular treatment, delay and water waste common in systems that require creation of a new slurry bed after each shutdown period.

New Bulletin W-212-B5 gives you the vital facts about this unique cold process water softening method. Write for your free copy today.

Worthington engineers and builds equipment for all the major types of water-conditioning systems, therefore is in an excellent position to give comprehensive and well-balanced recommendations on your water-conditioning equipment problems . . . further proof that *there's more worth in Worthington*. Worthington Corporation, Water Treating Section, Harrison, N. J.

J.1.3

Worthington Makes More of the Equipment for ALL Types of Water Conditioning Systems

WORTHINGTON

Water Conditioning

STAINLESS STEEL DEAERATING TANK is hoisted in place during construction of one of Detroit Edison Company's Heating Plants at Detroit, Michigan.

When CO_2 Caused a Headache ...Worthington Cured It

Detroit Edison had the solution to its problem—the problem of CO_2 in its steam—except for one thing.

Zeolite-softened municipal water used in their steam plant contains high percentages of carbonates which decompose and generate CO_2 in the boilers. Carried over with the steam into heating and processing equipment, that CO_2 could cause plenty of trouble.

The CO_2 problem was solved by Detroit Edison engineers by acid treating the softened water, converting the carbonates to CO_2. The gas thus formed is driven off in a deaerator.

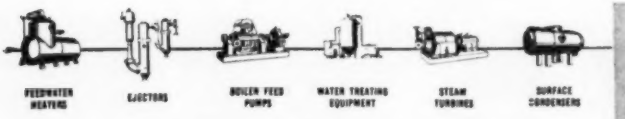
However, no standard deaerator could successfully remove the large quantities of CO_2 released by the acid treatment, and deliver water to the boiler with practically zero oxygen and zero CO_2. Furthermore, standard materials would have lasted only a few months under such conditions.

NON-CONTAMINATED STEAM

Worthington provided the answer. Detroit Edison engineers selected a Worthington deaerator specially designed for these severe conditions, built entirely of stainless steel, and guaranteed to deliver water containing not over 0.005 ppm of oxygen and not over 0.1 ppm of CO_2. The result is steam containing so little CO_2 that the amount *cannot be accurately measured!*

On problems like this one, Worthington not only furnishes *all* of the equipment needed in a complete water treating installation, but also has the engineering ability to work with your engineers on the *complete* problem of generating steam for power or processing. For further information on why *there's more worth in Worthington*, address Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, New Jersey.

S12



A GREAT TEAM IN STEAM

WORTHINGTON

Feedwater Heaters

News
of men and companies

(Continued from page 124)

The International Nickel Company, Inc.—E. M. Kline succeeds H. M. Brown, retired, as genl mgr of the Huntington (West Virginia) Works. C. K. Crosby is appointed asst genl mgr succeeding Kline.

Link-Belt Co.—Announces appointment of G. A. Most, Jr., to district mgr at Moline, Ill., succeeding S. T. Penick.

S. T. Penick **G. A. Most, Jr.**

Penick is appointed sales engineer to specialize in power plant coal handling equipment at the new Colmar plant, which will begin operations this year.

Owens-Illinois Glass Co.—C. M. Call, former New York sales engineer for the Kaylo Div., has been reassigned to the Albany area after 18 months of duty with the Marines, including service in the Korean theater.

Standard Pressed Steel Co.—B. D. Jones is made mgr of product development, a new post created to speed up development of new products. Named to succeed Jones as metallurgist is R. L. Sproat, an assistant.

Westinghouse Electric Corp.—Appointment of J. C. Fink as engineering mgr of industrial products is announced. J. S. Parry, Jr., is named asst mgr of the Apparatus Div. F. D. Weatherholt, formerly mgr of the Apparatus Div., moves to sales mgr of industrial products. In the Sturtevant Div. J. H. Spencer is appointed mgr of the northeastern region with hqtrs in Boston; H. F. Brush is named mgr of the middle Atlantic region with hqtrs in Philadelphia; R. Mercer is the new north-central region mgr with hqtrs in Cleveland; D. W. Davis, Jr. becomes mgr of the northwestern region with hqtrs in Chicago; W. J. Oonk is appointed mgr of the southwestern region with offices in St. Louis; D. M. Hutchinson is appointed mgr of the southeastern region with offices in Atlanta, Georgia.

OBITUARIES

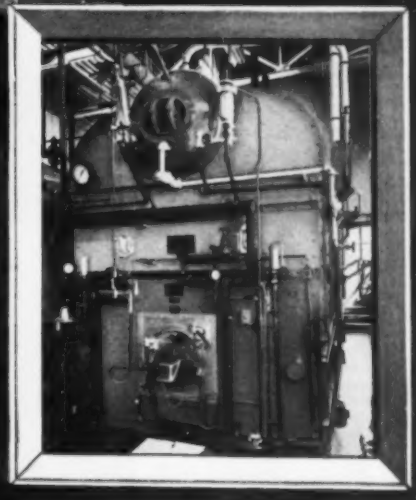
G. W. Eppler, genl mgr of the Monongahela Div. of Combustion Engineering-Superheater, Inc., passed away on June 8 at the age of 55.

A. L. Harding, formerly chief electrical engineer of Ebasco Services, Inc., died May 2, near Casablanca, of a heart condition after a long illness.

—End

Type B- BIGELOW

FIT INTO THE MODERNIZED STEAM PICTURE



Twin Bigelow "B's" Give The Bristol Company Modern Steam Production and Increased Capacity In Same Space As Two 39-Year Old Horizontal Return Tubular Boilers.

TYPE B FEATURES

In many cases, sizes up to 25,000 lbs. per hr. shipped completely assembled. Minimizes field work.

Water tubes along furnace side walls reduce maintenance.

High efficiency with any firing method.

Low head room. Maximum capacity for floor area.

Will take high overloads without disturbing water level.

Write for free catalog on Type B or on any of the units listed below.

BOILERS BY BIGELOW—Water Tube Boilers—Bent Tube Types • Two-Pass Boilers Horizontal Return Tubular Boilers • Scotch Type Boilers • Electric Steam Generators

BI-9

THE BIGELOW COMPANY • NEW HAVEN 3, CONN.
Established 1833

BIGELOW REPRESENTATIVES: Boston • New York • Chicago Philadelphia • Syracuse • Detroit • Atlanta • Milwaukee New Orleans • Oklahoma City • Petersburg, Va. • Washington, D.C. San Francisco • Los Angeles • Seattle • Knoxville

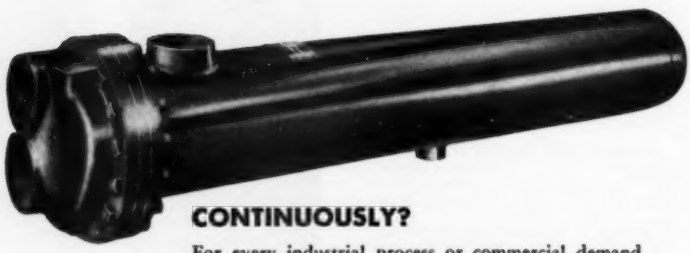
how do you want your HOT WATER?

INTERMITTENTLY?

Store up hot water for *intermittent* needs in a **p-k** copper lined storage heater. Supply of hot water is assured, even from a minimum steam supply.

The tank is completely lined with copper which keeps hot water pure and rust-free until needed. In fact, some of these **p-k** copper lined storage heaters are still turning out clear, clean hot water after more than 40 *years* of low-cost service.

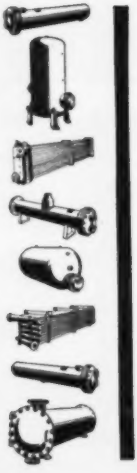
Check your own hot water needs—then check in with **p-k** for the most satisfactory, most efficient equipment to provide long-life service.



CONTINUOUSLY?

For every industrial process or commercial demand there's a **p-k** instantaneous hot water heater available. **p-k** heaters assure continuous hot water supply, to any needed capacity.

In **p-k** instantaneous heaters, temperature and expansion stresses have been eliminated—an assurance of dependable, safe operation. Plus the fact that **p-k** simplified construction permits easy, economical inspection and maintenance. Check your needs now with **p-k** for the right answer.



Closed Type Reclaimers • Condensate Coolers • Flexitube Reclaimers • Hot Water Storage Heaters (Vertical and Horizontal Types) • Instantaneous Hot Water Heaters • Open Pit Type Reclaimers

Copper Silicon Hot Water Storage Heaters

Cement Lined Hot Water Storage Heaters • Clad Steel Hot Water Storage Heaters

the **P-K** Patterson-Kelley Co., Inc.

1170 Burson Street East Stroudsburg, Pa.

1730

101 Park Avenue, New York 17 • Railway Exchange Building, Chicago 4 • 1730 Walnut Street, Philadelphia 3 • 96-A Huntington Avenue, Boston 16 • and other principal cities

Review of recent books . .

Write to the publisher for books in which you are interested

TEMA Standards

"Standards of Tubular Exchanger Manufacturers Association", third edition. Order from the Association, 53 Park Place, New York 7, N. Y. Semi-flexible cover, wire ring binding, handy filing size, 8½ x 11 in., 162 pages with tables. Price $5.50 postpaid.

The new TEMA Standards has 58 pages more than the previous edition. All former material has been revised and expanded, with additions to the mechanical and thermal standards. Two new sections have been added; one gives the mechanical standards for alloy steel heat exchangers, the other lists general information concerning heat exchangers. All features of the second edition as well as complete mechanical standards for alloy steel construction, known as Class A, make the book useful to industry and especially applicable to the chemical, petro-chemical and process industries.

This new edition will serve as a complete, self-contained reference source for designers and users of heat exchangers due to the General Information section that has been added, bringing into one volume not only helpful data formerly obtainable only from scattered sources, but tables recently made available on maximum allowable stress values of carbon, low and high alloy steels, nickel and high nickel alloys, copper and copper alloys, carbon, and low alloy steel pipe and tube.

Meetings and exhibitions

For additional information, please write sponsors of meetings

SEPTEMBER

Centennial of Engineering. Convocation period, comprising general meetings to be held in Chicago, has been scheduled for Sept. 3-13. For information write: 57th St. & South Shore Drive, Chicago 37, Ill.

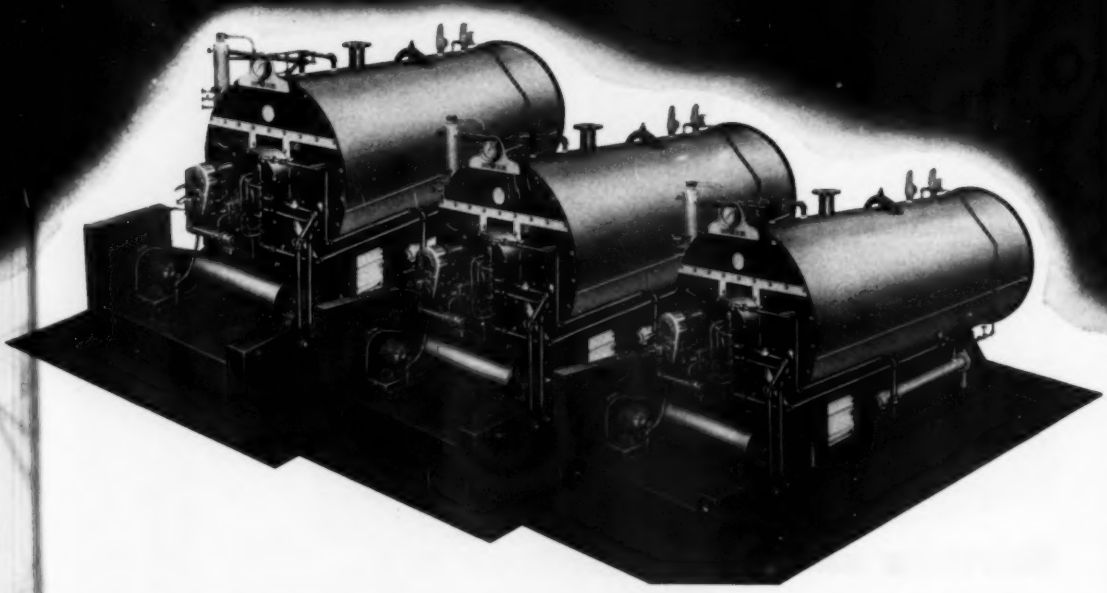
Instrument Society of America holds the National Instrument Conference and Exhibit in Cleveland, Sept. 8-12. For exhibit information contact Richard Rimbach, exhibit manager, ISA, 921 Ridge Ave., Pittsburgh 12, Pa.

National Electronics Conference will hold its 8th annual conference at the Sherman Hotel, Chicago, Ill., Sept. 29, 30 and Oct. 1. Details from S. R. Collis, chairman, NEC, 208 W. Washington St., Chicago, Ill.

Engineered
FOR SAFER AND MORE EFFICIENT REGULATION OF BOILER WATER LEVEL
Safety Alarm Water Columns
WRIGHT
BOILER TRIM
Low to High Pressure Gauge Valves
new catalog no. 700
WRITE FOR YOUR COPY TODAY
Reflex Gauges for High Pressures
● For 57 years Wright-Austin has concentrated on the manufacture of highest quality steam specialties. Our familiarity with steam users' requirements assures you of thoroughly practical designs in a complete line of Traps (cat. #600), Separators (cat. #500) and Boiler Trim (cat. #700).
Weighted and Compression Type Trycocks
WRIGHT-AUSTIN
COMPANY
3245 WIGHT STREET • DETROIT 7, MICH.
WA
Standard
STEAM USERS SINCE '94

1+1+1=7

WHEN YOU'RE COUNTING *Superior*



Battery installations of Superior Steam Generators provide extreme flexibility to meet the most widely fluctuating steam demands. A hospital installation illustrates the point.

From early June through September, steam demand is limited to the needs of hot water and sterilization. Any one of the three units carries this load with ease . . . and at higher efficiency than could be obtained by minimum operation of a larger boiler.

When cold weather adds its heating load, a second Superior Steam Generator is fired. Only the most severe weather demands firing the third unit . . . which throughout the rest of the year provides stand-by equipment which is desirable in any operation.

By employing different combinations of the three, (7 in all) allowing each unit in turn to share the load; all enjoy longer life at maximum efficiency . . . and by using only the number dictated by the steam demand, maximum economy at every stage of steam demand is assured.

Let us show you how battery installation can serve you better in your new plant . . . or augment your present steam facilities.

Write today for Catalog 402

for performance you can **BANK** *on*

SUPERIOR STEAM GENERATORS

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 18, N.Y.

3 *special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in*

ENGINEERED PLANT SERVICES

1. NEW EQUIPMENT

Begins on page 8

Contains highlights of new products by leading manufacturers, briefed and illustrated for your easy reference. Complete data on each of these products are available ***free.***

2. NEW BULLETINS

Begins on page 146

Includes descriptions of only those bulletins and catalogs that are really ***new*** and of ***direct value*** to you — saves your reading time, yet gives you full service. All bulletins sent to you ***free*** on request.

Anti-Corrosion Bulletins

See page 108 for bulletins that supplement the special report on Industrial Corrosion featured in this issue.

3. READERS GUIDE TO ADVERTISED PRODUCTS

Begins on page 133

Designed to catalog advertised products for your convenience in finding the ads which are of special interest to you at this time. Also lists those important bulletins, catalogs and working data offered ***free*** in the advertisements.

REQUEST CARD FOR LITERATURE OR MORE INFORMATION—July, 1952

To: INDUSTRY AND POWER, St. Joseph, Mich. Please have forwarded to me, at no obligation, the literature I've indicated by the following key numbers:

New Equipment begins Page 8	*New Bulletins begins Pages 108 & 146*	*Advertised Products begins Page 133*
No's	No's	No's

Your Name _____ Title _____

Your Company _____

Co. Address (St. & No.) _____

City _____ State _____

Inquiries for items listed in this issue not serviced beyond November 1, 1952

FIRST CLASS
PERMIT No. 19
(Sec. 34.9, P.L.&R.)
ST. JOSEPH, MICH.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3¢—POSTAGE WILL BE PAID BY

INDUSTRY AND POWER

420 MAIN STREET

ST. JOSEPH, MICH.

3 special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in

ENGINEERED PLANT SERVICES

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Your Name _____ Title _____

Your Company _____

Co. Address (St. & No.) _____

City _____ State _____

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Readers' guide to advertised products

This department is both a product index for advertising and a keyed listing for advertised literature. Refer to advertisement on page indicated and contact advertiser directly—or list paragraph key numbers on reader service card (page 131) to get data you want

AIR & DUST FILTERS & COLLECTORS

Fume Control Systems **500**
Literature available on fume control systems. The Kirk & Blum Mfg. Co. p 135.

Dust Collectors **501**
Bull 164-3 describes Norblo automatic bag type dust collection. The Northern Blower Co. p 141.

Electrical Precipitators **502**
Bull FA contains data on Cottrell precipitators with rapping system. Research Corp. p 44.

Electrical Precipitators **503**
Bull C103 contains 28 pages of data on Cottrell electrical precipitators. Western Precipitation Corp. p 147.

ANTI-CORROSIVE & PROTECTIVE COATINGS

Rust Preventive **504**
Adv. p 65 contains coupon for complete information on Rust-Oleum sealing compound. Rust-Oleum Corp.

BOILERS & BOILER ACCESSORIES

Boilers
Adv. p 127 contains data on Bigelow HRT boilers. The Bigelow Co.

Wickes Boilers **505**
Complete data available on Wickes boilers. The Wickes Boiler Co. p 113.

Water Gages **506**
Bull WG-1811 describes Yarway flat glass gages that may be equipped with Type "M" illuminator that shines like a star. Yarnall-Waring Co. p 47.

Boiler Trim **507**
Cat 700 contains data on boiler trim. Also data on traps (Cat 600) and separators (Cat 500). Wright-Austin Co. p 129.

Continuous Blowdown Equipment **508**
Free blowdown chart available on Henszey packet-type automatic continuous blowdown. Henszey Co. p 150.

Steam Generators
Adv. p 165 gives information on Union "H" type steam generator. Union Iron Works.

BUILDING HEATING, VENTILATING & AIR CONDITIONING & REFRIGERATION

Air Handling Equipment
Information on heating, cooling, drying, air conditioning and air handling equipment. American Blower Corp. p 54.

BUILDING MATERIALS & MAINTENANCE

Vacuum Cleaning Equipment
Information on Hoffman heavy-duty vacuum cleaning equipment. U. S. Hoffman Machinery Corp. p 164.

Pipe Sealing Compound **509**
Bulletins describe Weco Hi-Speed Seal, a leak-proof coating for pipe threaded connections. Weil Equipment Mfg. Corp. p 156.

Maintenance Handbook **510**
40-page Handbook on commutator and slip ring maintenance. Ideal Industries, Inc. p 153.

Thread Compound **511**
Free sample and data sheet on Fel-Pro C-5 "Hi-Temp" thread compound. Felt Products Mfg. Co. p 162.

COAL, ASH & BULK HANDLING

Coal Handling Equipment **512**
Bull 300 contains complete story on G-W coal handling system. Gifford Wood Co. p 115.

Belt & Bucket Elevators **513**
Bull 151 contains complete facts on Hewitt-Robbins belt & bucket elevators. Hewitt-Robbins Inc. p 142.

Electric-Vibrating Feeders
Adv. p 41 contains data on Jeffrey-Traylor electric-vibrating feeders for coal and other materials. The Jeffrey Mfg. Co.

Coal Handling Equipment **514**
Book 2410 contains drawings and photographs of many outstanding coal handling systems. Link-Belt Co. p 3.

Pulverizers
Adv. p 152 contains data on Mikro-pulverizers. Pulverizing Machinery Co.

Vibratory Feeders **515**
Catalog contains data on Syntron Vibratory Feeders. Syntron Co. p. 134.

Hopper Accessories **516**
Illustrated folders contain data on Syntron hopper level switches, electric vibrators and flow control valves. Syntron Co. p 157.

COMPRESSORS

Motor-Driven Compressors **517**
Information available on CP motor-driven compressors. Chicago Pneumatic Tool Co. p 48.

(Continued on page 134)

PRODUCT INDEX

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ANOTHER PERMUTIT® PRODUCT

Readers' guide to advertised products

(Continued from page 133)

CONTROLS, REGULATORS & INSTRUMENTS

Level Control **518**
Bull available on floatless level control for open and pressurized vessels. Leslie Co. p 145.

Indicators and Recorders **519**
Free booklet contains data on Ranarex indicators and recorders. The Permutit Co. p 134.

Combustion Control **520**
Case histories and booklet on "Boiler Plant Instrumentation." Bull R-8 describes Hays combustion control system. The Hays Corp. p 116.

Temperature Control **521**
Bull 1200 gives complete details on entire Spence line of automatic regulating valves, strainers and desuperheaters. Spence Engineering Co., Inc. p 42.

Temperature Regulator
Adv. p 160 contains data on the Sarco pilot-operated temperature regulator. Sarco Company, Inc.

pH Control **522**
Data File 82-88 contains details on Beckman pH equipment. Beckman Instruments, Inc. p 136.

Tank Gage **523**
Details available on Liquidometer tank gage. The Liquidometer Corp. p 156.

Gas Analyzer **524**
Bull 148BP contains information on Cambridge dissolved oxygen recorder and dissolved hydrogen recorder. Cambridge Instrument Co., Inc. p 138.

Temperature Indicators & Recorders **525**
Cat G-143-B describes many styles of Auto-Lite temperature indicators and recorders. The Electric Auto-Lite Co. p 158.

DIESELS

Diesel Engines
Adv. p 26 contains information on Nordberg diesel and Duafuel engines. Nordberg Mfg. Co. p 102, 103.

ELECTRICAL DISTRIBUTION

Low-Voltage Switchgear **526**
Coupon lists catalogs available on low voltage switchgear along with auxiliary and trip devices. I-T-E Circuit Breaker Co. p 102, 103.

Packaged Distribution Equipment **527**
Bull GEA-5600, "Electric Power—for America's Third Biggest Expansion" contains details. General Electric Co. p 31.

Dual-Element Fuses **528**
Coupon offers complete facts on Fusetron dual-element fuses. Bussmann Mfg. Co. p 14, 15.

Voltage Regulators **529**
Bull VA-180 gives complete specifications of Acme electric variable voltage regulators. Acme Electric Corp. p 150.

Fuses **530**
Price list and catalog on "Economy De-Lay" renewable fuses. Economy Fuse and Mfg. Co. p 58.

Interlocked Armor Cable **531**
Cat "G-E Interlocked Armor Cable," Pub. No. 19-211 contains complete facts. General Electric Co., Construction Materials Div. p 39.

Magnetic Starters **532**
Illustrated bulletins on Type "RA" magnetic starters. The Arrow-Hart & Hegeman Electric Co. p 149.

Circuit Breakers **533**
Bulls 1010 and 1410 contain complete facts on Heinemann circuit breakers. Heinemann Electric Co. p 163.

FANS & BLOWERS

Fans
Adv. p 4 contains information on Clarage fan equipment. Clarage Fan Co.

Fans & Ventilators **534**
Coupon offers complete data on Coppus blowers and ventilators. Coppus Engineering Corp. p 49.

Exhaust Fan
Information on Gallaher air van power exhauster for expelling moisture and fumes. The Gallaher Co. p 160.

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Steam Turbines **535**
Bull SW-51 contains data on auxiliary steam turbines. L. J. Wing Mfg. Co. p 164.

FUELS & FIRING EQUIPMENT

Coal **587**
Reference chart shows fuel properties you require for your particular combustion job. Eastern Gas & Fuel Assoc. p 23.

Binfeed Stokers **536**
Brochure on binfeed stokers contains blue-prints and plan of model stoker installation. Canton Stoker Corp. p 50.

Coal
See adv. p 51 for information on bituminous coal. Bituminous Coal Institute.

Stokers **537**
Coupon offers bulletins on Erie underfeed and spreader stokers. Erie City Iron Works. p 18, 19.

Coals
Information on Bell & Zoller coals. Bell & Zoller Coal Co. p 40.

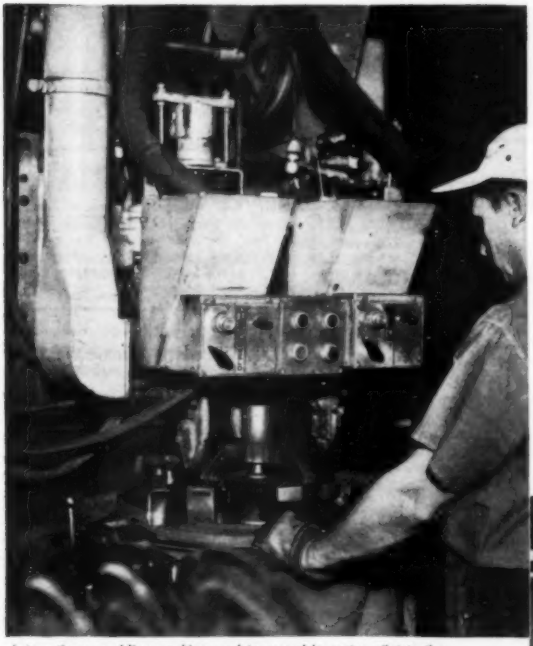
Stokers **538**
Data and free survey available on automatic coal stokers. Combustioneer Div., The Steel Products Engineering Co. p 114.

Coal
Complete data on Southern's engineered, industrial coal. Southern Coal Co., Inc. p 61.

(Continued on page 136)

THE INVISIBLE TOOL
at work in the
FORD AUTOMATIC TRANSMISSION PLANT
NUMBER 3 OF A SERIES

KIRK AND BLUM SYSTEMS CONTROL FUMES IN WELDING



Automatic arc welding machine used to assemble center pilot to the fly wheel disc of the automatic transmission. Fumes are removed below the breathing level of the operator.

All types of fume-making operations in this large plant are controlled by a number of KIRK & BLUM Systems. Each was designed to do its specific job with utmost efficiency. Here, welding machines are exhausted, keeping smoke and fumes from the plant air.

In the ultra-modern Ford Motor Company Automatic Transmission Plant, 37 distinct KIRK & BLUM Systems aid in the production of Merc-o-Matic and Ford-o-Matic transmissions. In heat treating, quenching, welding, cleaning, machining, woodworking, maintenance and assembly operations, they provide "Clean Air . . . the INVISIBLE Tool" in this model plant.

Let the experience of KIRK & BLUM engineers work for you. Write for free literature. The Kirk & Blum Manufacturing Co., 3174 Forrer St., Cincinnati 9, Ohio.

Induction welding machine used to assemble a ring gear to the fly wheel disc. Here a complete hood is used and fumes are collected above the operator's head.

KIRK AND BLUM
FUME CONTROL SYSTEMS

lengthen the life...
increase the efficiency...
reduce operating costs...

IN YOUR POWER PLANT!

4 PROBLEMS

you can solve with

BECKMAN pH Control

Make vitally important savings in the cost of operating and maintaining your power plant by Beckman-controlling the pH of your feed water and steam processes. You can protect costly plant equipment against damaging calcium deposits . . . can reduce requirements of costly chemicals and treating materials.

There is a size and type of Beckman pH meter—from strictly portable to installed, completely-automatic pH control—for every power plant requirement.

1 REDUCE COSTLY CORROSION

(especially in steam condensate equipment). Rate of corrosion is a function of the pH of the water. Maintaining high pH minimizes corrosion through formation of protective oxide coatings. pH must be sufficiently high to minimize corrosion, yet low enough to prevent calcium precipitation (see below). **Peak efficiency can be obtained only through accurate pH control!**

2 PREVENT CALCIUM DEPOSITS

For each type of softening operation there is a definite pH at which optimum precipitation of calcium is obtained. By controlling the pH, minimum residual hardness is assured. Then, what little hardness remains, is prevented from precipitating in condensers, exchangers, valves, etc., by **lowering** the pH in this part of the system. **Again—peak efficiency can be obtained only through accurate pH control!**

3 OBTAIN MAXIMUM EFFICIENCY

in removing impurities through coagulation. Formation of the floc is greatly influenced by the pH of the solution and type of coagulant used. If alum is used, maximum floc is obtained at a moderately acid pH value . . . if sulphates predominate a **lower** pH value gives best floc . . . while if chlorides predominate, a **higher** pH value (slightly alkaline) must be maintained. **Optimum sedimentation can be obtained only through accurate pH control!**

4 PROTECT VALUABLE ZEOLITE

Zeolites are rapidly disintegrated by water with **low** pH and are also softened and disintegrated by water of **high** pH. By Beckman-controlling pH before water enters Zeolite, costly chemical losses are eliminated and vital plant economies are effected. **Here again, topmost efficiency can be obtained only through accurate pH control!**

Illustrated at right is the Beckman Model R pH Indicator—the ideal equipment for power plant installations.

For more details on Beckman pH Equipment and the savings to be made in power plant applications, write for your free copy of Data File 82-88

BECKMAN INSTRUMENTS control modern industries

BECKMAN INSTRUMENTS, INC.
South Pasadena, California
Factory Service Branches: New York - Chicago - Los Angeles

BECKMAN INSTRUMENTS include: pH Meters and Electrodes - Spectrophotometers - Radioactivity Meters - Special Instruments

Readers' guide to advertised products

(Continued from page 134)

RotoGrate Stokers **539**
Bulletin contains information on Detroit RotoGrate stokers. Detroit Stoker Co. p 10, 11.

Spreader Stokers **540**
Coupon on p 119 offers full facts about Perfect spread stokers. American Engineering Co.

HEAT EXCHANGER EQUIPMENT

Water Heaters
Adv. p 128 contains data on P-K water heaters. Patterson-Kelley Co., Inc.

Deaerators
Adv. p 126 contains data on Worthington deaerators. Worthington Corp., Steam Power Div.

Condenser Tower **541**
Additional information available on the Vogt condenser tower. Henry Vogt Machine Co. p 62.

Heat Exchangers **542**
Bull 120 gives complete information on Niagara Aero heat exchangers. Niagara Blower Co. p 148.

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LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Turbine Lubricant **543**
Complete information available on Shell Turbo oil. Shell Oil Co. p 29.

Lubricant
Adv. p 166 contains data on Texaco Ursa oil. The Texas Co.

Turbine Oil
Adv. p 55 contains information on Nonpareil turbine oil. Standard Oil Co.

Oil Filters
Adv. p 156 contains data on Winslow oil filters. Winslow Engineering Co.

MATERIALS OF CONSTRUCTION

Copper & Copper Alloys **544**
Coupon offers booklet "Corrosion Resistance of Copper and Copper Alloys." The American Brass Co. p 100.

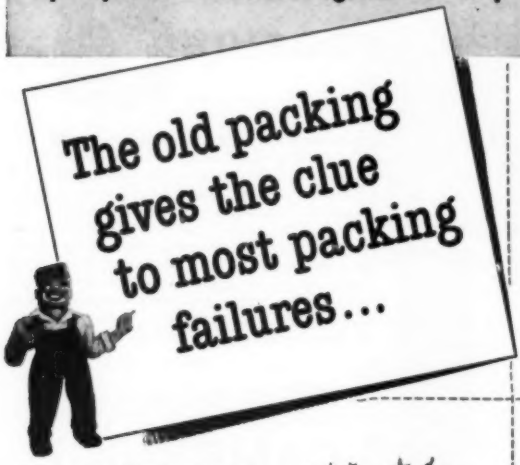
MECHANICAL POWER TRANSMISSION

V-Belts
Information on cog-belts and Thorobred V-belts. Dayton Rubber Co. p 111.

(Continued on page 139)

How to make packings last longer

Tips by Johns-Manville Engineers to help you keep production rolling



I was ruined by shaft misalignment. When old packing shows excessive reduction in cross-section directly beneath rod, shaft or plunger, bad alignment is indicated. Leakage usually occurs around top of shaft or rod. Cause may be worn bearings which permit shaft to whip.

Too much gland pressure did me in. Badly deformed rings next to the gland follower, with bottom rings in fair condition, suggest excessive gland pressure or improper installation. Excessive gland pressure sometimes causes packing to extrude between follower and rod or shaft.

Lack of lubrication made things too hot for me. If the wearing faces of the rings are dried out or charred, with the rest of the packing in usable condition, the trouble probably is lack of lubrication. Excessively high operating temperatures and wrong type of packing can cause similar symptoms.

I'm worn out because I turned with the shaft. Unusual wear on the outside circumference of the packing almost always indicates one of two conditions. The rings may be binding on the shaft and rotating with it, or the packing is too loose in the stuffing box and moving with the rod.

Why you can count on Johns-Manville

INTERLOCKED ROD PACKING

Because it's braided square, not braided round and pressed square, J-M Interlocked Packing lasts longer . . . has a better contact area . . . makes a tight seal with medium gland pressure. J-M Interlocked is recommended for both reciprocating and rotating service, for use against steam up to 500°F; hot and cold fresh and salt water; oils; weak acids and caustics.

Your distributor will help, too! Your J-M Packing Distributor can help you take the guesswork out of packing problems. He carries complete stocks of Johns-Manville quality packings and can supply you promptly. For the address of the J-M Packing Distributor nearest you, write Johns-Manville, Box 60, New York 16, N. Y.

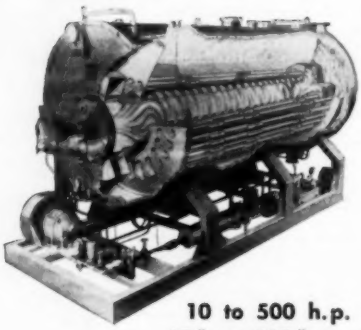
JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

AMESTEAM GENERATOR

I BOUGHT ONE! Because It's

EASY TO INSTALL
EASY TO OPERATE
EASY TO CLEAN



10 to 500 h.p.
15# to 200# w.p.
OIL or GAS

WRITE FOR BULLETIN 1050

AMES IRON WORKS

BOX J-7 OSWEGO, N. Y.

Builders of Better Boilers Since 1848

PREVENT BOILER CORROSION

Oxygen, one very active source of destructive boiler corrosion, is continuously detected and recorded by the Cambridge Gas Analyzer. The oxygen dissolved in the feed water is determined directly, and continuously recorded upon the Cambridge Dissolved Oxygen Recorder. The oxygen set free by dissociation in the boiler is determined by measuring the free hydrogen in the steam which is recorded upon the Cambridge Dissolved Hydrogen Recorder. Cambridge Analyzers are available in models for continuously recording either O_2 or H_2 separately or O_2 and H_2 simultaneously.

Send for Bulletin 148 B.P.

CAMBRIDGE INSTRUMENT CO., INC.
3040 Grand Central Terminal New York 17, N. Y.

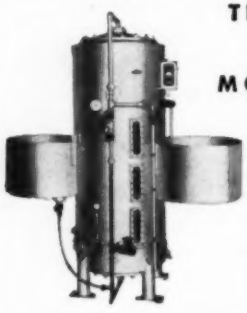
CAMBRIDGE
DISSOLVED O_2 & H_2 ANALYZERS

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

HIGH PURITY WATER

For Boiler Feed, Process & Other Needs

THE LOW COST*
Penfield
MONO-BED WAY



Operating on the most efficient deionizing technique known (intimately mixed cation and anion resins in a single unit tank), the raw water passes through a Penfield Mono-Bed Demineralizer only once — *yet comes out with a mineral content of virtually zero.* No heat or steam power is ever required, and regeneration of the resins is accomplished by simple gravity and displacement methods.

***COSTS LESS TO PURCHASE, OPERATES FOR LESS THAN 15¢ PER 1000 GALS.**

Whether your requirements for dependable, high-purity water are 10 g. p. h. or 10,000 g. p. h., there is a Penfield "Planned Purity" System waiting to make important savings for you in both original equipment and operating costs. Write today for new catalog showing all Penfield water-treating equipment.

PENFIELD MANUFACTURING CO., INC.
19 High School Ave., Meriden, Conn.
FILTERS · SOFTENERS · DEGASIFIERS · DEMINERALIZERS

Penfield "Planned Purity" PAYS!

Readers' guide to advertised products

(Continued from page 136)

Roller Chain
Adv. p 52 contains data on Atlas "Super-Life" chain. Atlas Chain & Mfg. Co.

Condor V-Belts **545**
Bull 6868D describes Condor V-belts. Raybestos-Manhattan, Inc., Manhattan Rubber Div. p 63.

V-Belts
Adv. p 45 contains information on Gates V-belt drives. The Gates Rubber Co.

Grommet V-Belts
Adv. pages 35, 36, 37, 38 discuss Goodrich grommet belts. The B. F. Goodrich Co., Industrial Products Div.

Universal Joints **546**
Descriptive literature available on Lovejoy universal joints. Lovejoy Flexible Coupling Co. p 155.

PACKAGED STEAM GENERATORS

Packaged Automatic Boilers **547**
Literature describes Continental packaged automatic boilers. Boiler Engr. and Supply Co., Inc. p 43.

HOW TO REQUEST FREE LITERATURE

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Packaged Steam Generator **548**
Cat PG-51-2 and article "Water Tube Package Steam Generators" available. Foster Wheeler Corp. p 107.

Amesteam Generator **549**
Bull 1050 contains data on the Amesteam generator. Ames Iron Works. p 138.

Steam Generators **550**
Coupon p 122 offers catalog on Clayton forced recirculation steam generators. Clayton Mfg. Co.

Packaged Steam Boilers **551**
Catalog contains full story on Cleaver-Brooks self-contained steam boilers. Cleaver-Broo Co. p 39.

PACKING AND GASKETS

Packings
Information on Johns-Manville packings. Johns-Manville Corp. p 137.

Gaskets
Adv. p 140 contains data on Ajax spiral wound gaskets. United States Gasket Co.

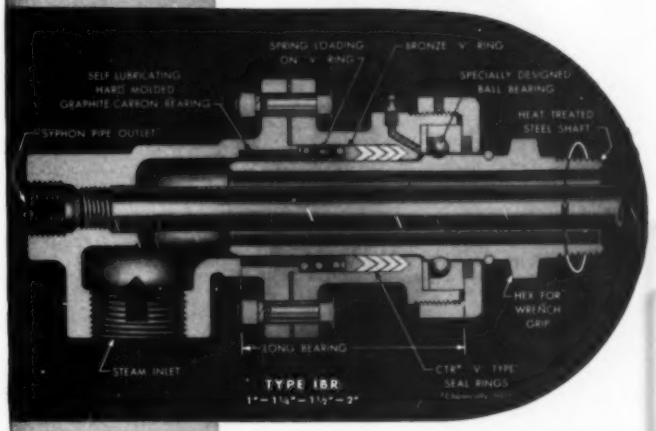
Packings **552**
Cat PC-101 gives complete information on Palmetto Packings. Greene, Tweed & Co. p 157.

PIPE AND FITTINGS

Flexible Metal Hose **553**
Bulls SS-50 and CC-300 contain full de-

(Continued on page 140)

BARCO *Revolving* JOINTS


SPRING LOADING ON "V" RING
BRONZE "V" RING
SELF LUBRICATING HARD MOLDED GRAPHITE CARBON BEARING
SPECIALLY DESIGNED BALL BEARING
HEAT TREATED STEEL SHAFT
SYPHON PIPE OUTLET
HEX FOR WRENCH GRIP
LONG BEARING
STEAM INLET
CTR "V" TYPE SEAL RINGS
TYPE IBR.
1" – 1¼" – 1½" – 2"

Syphon Style—TYPE IBR. Built for 450°F., steam service to 150 psi, and up to 300 RPM. Hydraulic service to 200 psi, 750 RPM. Higher pressure and speeds under certain conditions.

Single Flow Style—TYPE IBRSA. Similar to Type IBR. Sizes 1" and larger have 2-piece flange connected body.

Up to 50% power savings!

PRODUCT DESIGNERS and plant engineers throughout the country have been quick to recognize the ADVANTAGES offered by Barco's new *improved* Type IBR Revolving Joint for service on drum type dryers, coating rolls, calenders, mixing drums, clutches, chucks, chill rolls, sanforizers, and other rotating machinery:

- Free-Floating, Low Torque Installations.
- Up to 50% Power Savings.
- Better Temperature Control where steam is used for heating rolls.
- Low Maintenance; No Adjusting.
- Ability to Withstand Vibration and Hard Usage.
- All Parts Easily Accessible.

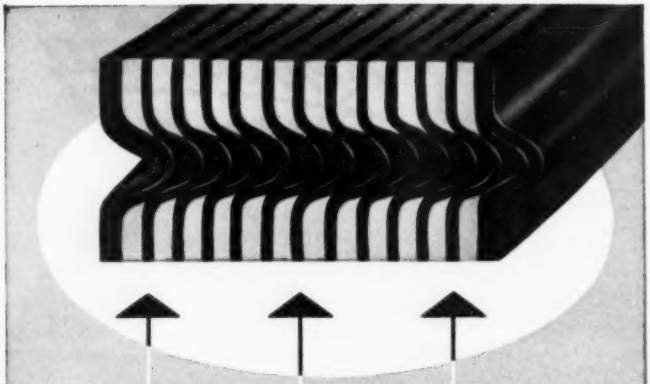
Barco builds a complete line of revolving joints for steam, water, air, oil, gas, and hydraulic service. Sizes from ¼" to 5". Pressures to 250 psi, steam, or 1000 psi, hydraulic. Speeds to 2500 rpm. *Barco Engineers are at your service; ask for recommendations.* BARCO MANUFACTURING CO., 1831H Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd.

Send for a copy of BULLETIN 300

WORLDWIDE SALES and SERVICE

BARCO

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING AND REVOLVING JOINTS



Every Gasket an EXPANSION JOINT

Ajax Spiral Wound Gaskets are literally just that. The live-spring action of the U-shaped metal plies—like the convolutions of tiny expansion joints—give and take with varying pipe line or boiler stresses to seal joints tight at safe bolt loads, and keep them tight under all operating conditions.

There are types and sizes for all standard flanges and for manholes, handholes and tube caps of all makes of stationary and marine boilers, waterwalls, economizers and other boiler accessories.

Materials of construction include plated low carbon steel or stainless, Canadian or Blue African asbestos or chemically inert Teflon. Sold universally through industrial distributors. Ask your supply house or write—

UNITED STATES GASKET COMPANY

FABRICATORS OF "TEFLON" & "KEL-F" FOR THE CHEMICAL PROCESS & ELECTRONIC INDUSTRIES

CAMDEN 1 NEW JERSEY

Readers' guide to advertised products

(Continued from page 139)

tails on American flexible metal hose and tubing. The American Brass Co., American Metal Hose Branch. p 56.

Insulated Piping **554**
Section 480-6 contains data on pipe selection, flexibility, and expansion. The RicwiL Co. p 118.

Anti-Corrosion Pipe & Fittings **555**
Literature may supply answer to your problems involving transfers of corrosive liquids or gases. The Chemical Corp. p 144.

Revolving Joints **556**
Bull 300 contains complete information on Type IBR revolving joints. Barco Mfg. Co. p 139.

Flexible Metal Hose **557**
Cat 500 contains data on seamless & interlocking hose in bronze, steel & stainless steel. Atlantic Metal Hose Co., Inc. p 163.

Rubber Lined Pipe **558**
"Report on Economy of Rubber-Lined Pipe" contains case history that applies to corrosion protection in any field. La Favorite Mfg. Co. p 155.

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PUMPS

Mechanical Seal
Adv. p 32 contains data on BJ mechanical seals available in a number of engineered types for BJ pumps. Byron Jackson Co.

Controlled Volume Pumps
Information on Milton Roy controlled volume pumps for boiler water treatment. Milton Roy Co. p 21.

Motorpumps **559**
Details available on I-R motorpump line. Ingersoll-Rand. p 64.

REFRACTORY CONCRETES

Insulating Cement **560**
Cat, prices and free sample of Stic-Tite insulating cement available. Refractory & Insulation Corp. p 143.

Castable Refractories
Information on refractory concrete. Lumnite Div., Universal Cement Co. p 60.

Refractory Concrete **561**
Bull R-22 contains data on B&W Kaocast. The Babcock & Wilcox Co., Refractories Div. p 104.

SOOT BLOWERS & TUBE CLEANERS

Midget Tube Cleaners
Information on Airetool's midget tube cleaners. Airetool Mfg. Co. p 153.

(Continued on page 142)

Norblo
AUTOMATIC
Bag Type Dust Collection

Cutaway shows Norblo basic unit of 78 bags. Automatic shaking and bag cleaning, one unit at a time, insures full use of cloth area better than 99% of the time.

Rugged, Efficient, Economical
. . . Pays for itself Quickly

For continuous and heavy duty service at constant capacity and efficiency, Norblo Automatic Bag Type Dust and Fume collection pays its own way—in the recovery of valuable materials or the removal of injurious or "nuisance" industrial air contaminants. Norblo builds the entire installation, from blowers to bag-cleaning mechanisms. Complete systems are engineered to meet specific situations, production layouts and required capacities. Norblo engineering insures low maintenance and no shut-downs—guarantees performance of every installation. Write for Bulletin 164-3.

Norblo also builds centrifugal and hydraulic dust collectors, exhaust fans, cement air cooling systems and portable dust collectors.

THE NORTHERN BLOWER COMPANY

Engineered Dust Collection Systems for All Industries

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HEWITT-ROBINS

SAVINGS ARE UP... MAINTENANCE DOWN

With Hewitt-Robins Belt & Bucket Elevators

Whatever your specific requirements, a Hewitt-Robins Belt & Bucket Elevator offers you a lower-cost, more dependable method of handling your bulk materials . . . there are 58 standard types. styles and sizes to choose from.

Hewitt-Robins Belt & Bucket Elevators are equipped with load-matched belting that is specially designed to ward off the punishing pull of bucket bolts—resist slippage wear—ban mildew. This better belting is available in three types, with or without covers.

For lifting heavy tonnages of moderately abrasive material, under wet or dry conditions . . . *specify Hewitt-Robins Ajax® Belting.*

For general bucket operation, lifting light, moderately abrasive materials where economy rules, *specify Hewitt-Robins Conservo® Belting.*

For meeting unusually severe requirements such as handling heavy, abrasive or wet, gritty materials, *specify Hewitt-Robins Monarch® Belting.*

Get complete facts and figures on how you can save with a Hewitt-Robins Belt & Bucket Elevator . . . write for Bulletin No. 151.

HEWITT-ROBINS HR **INCORPORATED**
STAMFORD CONNECTICUT

Hewitt Rubber Division
Hewitt Rexfoam® Division
Robins Conveyors Division
Robins Engineers Division

Readers' guide to advertised products

(Continued from page 140)

STEAM SPECIALTIES

Impulse Steam Traps
Install a Yarway impulse steam trap on free trial anywhere in your plant. See adv. p 66. Yarnall-Waring Co.

Steam Traps **562**
Steam Trap Book gives advantages of Armstrong unit trapping. Armstrong Machine Works. p 2.

Traps **563**
Cat 751 (or see Sweet's) contains data on Nicholson expansion steam traps. W. H. Nicholson & Co. p 150.

Temperature Regulators **564**
Coupon on p 154 lists bulletins and data available on Atlas temperature regulators and other products. Atlas Valve Co.

Separators **565**
Pub. 2950 describes Cochrane all-service separators. Cochrane Corp. p 158.

TOOLS

Pipe Tools **566**
Catalog contains complete data on Toledo pipe tools and power pipe threading machines. The Toledo Pipe Threading Machine Co. p 151.

Proto Tools **567**
Send 10c for 68-page catalog of Proto tools. Plomb Tool Company. p 6.

Blower Suction Cleaner
Adv. p 160 describes Clements-Cadillac portable blower-suction cleaner. Clements Mfg. Co.

TURBINES

Turbines **568**
Book B-3896 describes Type E turbines. Westinghouse Electric Co. p 117.

Turbines **569**
Bull S-116 describes advantages of the Terry Solid-Wheel turbine. The Terry Steam Turbine Co. p 48.

Turbines
Adv. p 123 contains data on Worthington steam turbines. Worthington Corp., Steam Turbine Div.

VALVES

Rubber-Lined Valves **570**
Catalog describes rubber-lined metal valves with manual or automatic control. W. S. Rockwell Co. p 159.

Corrosion-Resistant Valves
See adv. p 25 for information on Aloyco corrosion-resistant valves. Alloy Steel Products Co., Inc.

Diaphragm Valves
Adv. p 27 gives information on Grinnell-Saunders diaphragm valves. Grinnell Co.

Check Valves **571**
Cat 30 contains complete data on Chapman tilting disc check valves. Chapman Valve Mfg. Co. p 120.

Stainless Steel Valves **572**
Folder Form 194 describes the complete line of Jenkins stainless steel valves. Jenkins Bros. p 9.

Corrosion-Resistant Valves
Adv. p 7 describes the Crane alloy plug gate valves for severe corrosive service. Crane Co.

Regulating Valves
Adv. p 124 contains information on Clark regulating valves. The Clark Mfg. Co.

Instrument Valves **573**
Bull 491 contains full story on Edward instrument valves. Edward Valves, Inc. p 53.

Rubber-Lined Valves **573**
Bulletin contains information on Darling rubber-lined gate and check valves. Darling Valve & Mfg. Co. p 112.

Pump Valves **575**
Cat gives 4 ways to cut pump repairs. Sims Pump Valve Co., Inc. p 160.

WATER TREATMENT

Ion Exchangers **576**
Bull 28X7808 describes alkalinity reduction by ion exchange. Allis-Chalmers Mfg. Co. p 57.

Return Line Corrosion **577**
Bull 5013 outlines causes of return line corrosion and describes its control. Dearborn Chemical Co. p 34.

Amine Treatment **578**
Bull CP 100 contains all facts on amine treatment. The Bird-Archer Co. p 30.

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Return Line Corrosion **579**
Tech. Bull 124 describes Betz filming amine treatment. W. H. & L. D. Betz. p 17.

Water Conditioning Systems **580**
Bull W-212-B5 contains facts on Worthington cold process water softening method. Worthington Corp., Water Treating Sec. p 125.

Water Treatment **581**
Available quarterly publication "Nalco Abstracts" contains abstracts of general and technical articles. National Aluminate Corp. p 13.

Automatic Control **582**
Bulletins contain data on automatic control of processes for removal of water impurities. Belco Industrial Equipment Div. p 121.

Water Conditioning **583**
Bull 552 contains information on Uniflow industrial water conditioning equipment. Uniflow Mfg. Co. p 156.

Dealkalization Process **584**
Complete details available on new process for softening and dealkalizing water. American Water Softener Co. p 33.

Water Treatment **585**
Catalog shows all Penfield water-treating equipment. Penfield Mfg. Co. p 138.

Softener System **586**
Details available on automatic Inversand zeolite water softener system. Hungerford & Terry, Inc. p 163.

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33	American Brass Co., The	"Corrosion Resistance of Copper & Copper Alloys"	544
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33	American Water Softener Co.	Dealkalization process	184
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AIR AND DUST FILTERS & COLLECTORS

Electrostatic Precipitators **200**

Series of three 4-page folders present case histories of electrostatic precipitators applied to various industries. Applications for cleaning blast furnace gas, for sulfate pulp process and for detarring applications are discussed. Construction details of the units also are described. Koppers Co., Inc., Koppers-Elex Precipitator Dept.

Cloth Tube Collectors **201**

How cloth tube dust collectors are handling complex problems in 33 typical installations is related in brochure dealing with fume and dust control. Installations discussed are in numerous varied industries. American Wheelabrator & Equipment Corp.

Exhaust Hoods **202**

"Manual of Exhaust Hood Design," 24-page brochure 270-E1, illustrates and discusses exhaust hoods for many operations in the metal working industries. In addition, dynamic and hydrostatic dust precipitators and systems for control of oil mist are discussed. Engineering data are given in tabular form. American Air Filter Co., Inc.

ANTI-CORROSIVE & PROTECTIVE COATINGS

Protective Coating **203**

Descriptions of Dum Dum, a protective coating for metal, are contained in a 16-page progress report. Results to date of a continuing series of tests in the field and research laboratories to determine extent of protection provided are summarized. The Arco Co.

Protective Coatings **204**

Coatings used to prevent corrosion of industrial equipment in chemically contaminated atmospheres, to waterproof buildings and to provide a vapor barrier over thermal insulation are the subject of 44-page catalog GM101. Related products such as caulking compounds, primers and membraning material also are described. Insul-Mastic Corporation of America.

Rust Preventative **206**

Phosphatizing treatment for operating ferrous parts is described in 4-page folder. An oil-retaining rustproof surface is produced. How it works, how to apply, advantages and typical applications are presented. Octagon Process, Inc.

Anti-Corrosive Coatings **207**

If the floors, walls, ceilings or structural steel of your plant are subject to chemical corrosion, you may find data sheet 501 useful. Resistance of manufacturer's line of protective coatings to practically all commonly used corrosive chemicals is listed in chart form. Coatings are also used for equipment such as tanks, pipes, ducts and machinery. Prufcoat Laboratories, Inc.

BOILERS & BOILER ACCESSORIES

Bent Tube Boilers **208**

Two drum, bent water tube boilers are the subject of 14-page brochure. Low head types are included. Furnaces are designed for various types of firing, and water walls are available. Presentation is by specifications and side elevation drawings of actual installations. Henry Vogt Machine Co.

CONTROLS, REGULATORS & INSTRUMENTS

Low Pressure Regulators **209**

Design features and advantages of low pressure regulators are presented in data sheet 150. Pressure range is 0-75 WSP with valve body sizes of 1½ and 2 in. Stets Co.

Temperature Control **210**

Construction features of a control unit for automatically monitoring up to 20 individual temperature points per minute are presented in 8-page brochure 4703. In addition to explanations of how it works, schematic drawings suggest applications. How manually operated pyrometer systems can be converted to automatic also is explained. Illinois Testing Laboratories, Inc.

Temperature Regulators **211**

Specifications for various types of temperature regulators are given in mechanical drawings contained in 18-page bulletin 50-1000-08. Information on the why of control accuracy as well as on installation, care and maintenance is presented. Also lists accessories. Farris Stacon Corp.

Regulating Valves **212**

Design features, performance and specifications of double seated, diaphragm regulating valves for use with control instruments are described in 4-page folder 513. Cooling bonnets are available for over 500 F and under 30 F. Leslie Co.

ELECTRICAL DISTRIBUTION

Motor Controls **213**

"Electrically Speaking," 84-page catalog M-78A, has been prepared as a quick reference guide for the various motor controls and allied equipment available. Described in the booklet are diversified products such as magnetic brakes, clutches and separators, controls, switches, regulators, starters, resistors, rheostats, electronic equipment and heater elements. Cutler-Hammer, Inc.

(Continued on page 148)

Thermocouples **205**

Recommendations for application and information concerning instrument sensing units and associated accessories are contained in illustrated 42-page data book and catalog TC-9. Listed in the table of contents are many types of thermocouples, radiation detectors, resistance bulbs and accessories for indicating, controlling and recording instruments. Data pertaining to making, checking, selecting and ordering thermocouples, wire sizes and resistances make this manual a useful asset in applying indicating, controlling and recording instruments. Barber-Colman Co., Wheelco Instruments Div.

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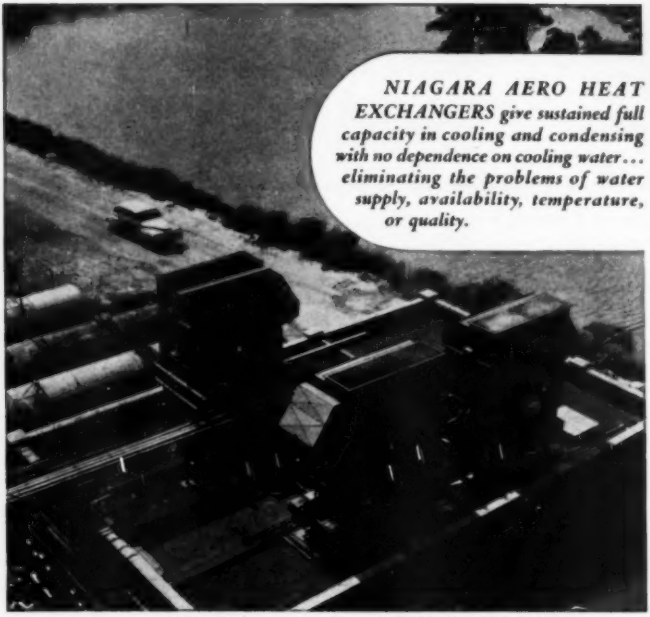
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New bulletins and catalogs

(Continued from page 146)

Cable Connectors **214**

Recommendation charts contained in 36-page catalog AL53 detail advantages of connectors for specific applications in tapping and splicing aluminum conductor in overhead distribution. Tools and accessory equipment are presented. A technical section outlines problems involved in connecting aluminum and their solutions, as well as tables of physical properties and current ratings of aluminum cable. Burndy Engineering Co., Inc.

Cables **215**

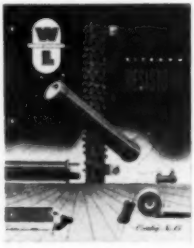
Savings resulting from smaller cable sizes are possible if cable with A.V.C. sandwich insulation is used, according to folder. Advantages are listed and a table compares current carrying capacities. Rockbestos Products Corp.

Motor Control Centers **216**

How to lay out a motor control center is explained in 8-page folder 400. Construction features, advantages and specifications for the units are presented. Continental Electric Equipment Co.

Resistors **217**

How to select the proper resistor is told in the data section of 64-page catalog 15. In addition, a quick selector chart is employed. Useful data for the engineer includes list of basic equations, nomographs of Ohm's law and parallel resistance, and



information on ordering procedure. Descriptions and specifications for numerous types of resistors, both stock and made-to-order, are given. Terminals, mountings and enclosures are also presented. Ward Leonard Electric Co.

Switchgear **218**

Low and medium voltage types of switchgear are the subject of 8-page catalog 521. Applications and basic specifications as well as panels, components and construction are described. Other products made by the company are also listed. Electric Service Engineering Co.

D-C Power Supply **219**

Described in 4-page folder V1051 is a unit which supplies a source of variable stabilized-regulated d-c voltages, operating from a-c power lines. How it works, advantages, applications and operation are discussed. The Superior Electric Co.

Circuit Breakers **220**

History of modern circuit breakers and fundamental operating principles are included in 36-page booklet B-5407. Eight basic types of units are outlined, including

construction details, ratings, dimensions and typical applications. All engineering data required for proper selection of equipment is included. Westinghouse Electric Corp.

Wires & Cables **221**

Tabulated for quick reference, 16-page catalog briefly describes and illustrates wires and cables for many purposes. Discussions of conductor strandings and protective coverings are also presented. Wire and cable selector table lists required services, recommended product, and types of insulation and covering recommended. Simplex Wire & Cable Co.

Unit Substations **222**

"Electric Power for Industry's Third and Biggest Expansion," 24-page booklet GEA-5600, tells the importance of proper electrical facilities when planning for plant expansion. Advantages of "packaged equipment" in the form of unit substations and switchgear are explained. Typical layouts are shown. General Electric Co.

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Electrical Fittings **223**

Solderless wire connectors, cable and conduit fittings and wiring devices are presented in an illustrated quick reference style in 10-page catalog 52. Specifications, dimensional data, application instructions and ordering information are included. Buchanan Electrical Products Corp.

BUILDING HEATING, VENTILATING & AIR CONDITIONING & REFRIGERATION

Air Conditioning **224**

Specifications for air conditioning equipment are listed in 4-page folder 29a/BU. Horizontal and vertical air handling units, water or steam coils, evaporative condensers and cooling towers are included. Bulletins containing complete descriptions of specific equipment are listed. Bush Manufacturing Co.

Filters **225**

Construction, advantages, specifications and performance data of ventilation and air conditioning filters are outlined in 8-page bulletin 100. Automatic, dry panel, grease, viscous panel and spray booth types are featured. Dollinger Corp.

Smoke Indicators **226**

Panic caused by accidental introduction of smoke into air conditioning systems can be averted by use of smoke control alarms, according to 4-page folder 521. Details of three models of control units are outlined. Ess Instrument Co.

COAL, ASH & BULK HANDLING

Rolling Ring Crusher **227**

Construction features of a rolling ring crusher for reducing coal and other materials to uniform size are described in 8-page bulletin. Engineering data and typical installations in mines and power plants are presented. American Pulverizer Co.

Conveyor Belting **228**

How to lay out conveyer and elevator drives and specify the proper belt is explained in 30-page catalog NY-1697-C. Data on carrying capacities, horsepower

(Continued on page 151)

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ADDED PERFORMANCE

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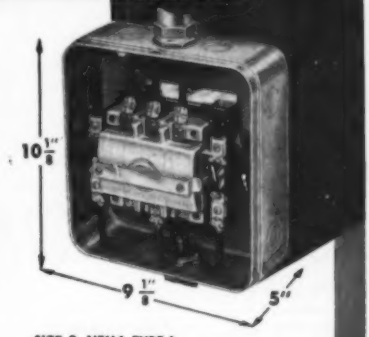

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The "RA", Right Angle, balanced operating mechanism is the first real advance in starter design since the introduction of the original solenoid type. This revolutionary new concept makes it possible for Arrow-Hart to build added performance into starters just ½ the size of outmoded models. The time-tested bellcrank principle is utilized to produce a mechanical advantage which makes it possible for a small, compact magnet to outperform the old fashioned direct-action type. Precision alignment of the rugged, heavy duty contacts is made with a stronger, more positive action. The alkyd base and hood are designed for superior arc control. To safeguard against motor burnout and other damage, every "RA" starter is equipped with overload protective relays which trip under adverse current conditions.

Whatever your starter requirements, you'll find the right Arrow-Hart "RA" starter to do the job better.

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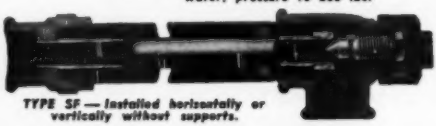
This Plant Claims Their HEAT SAVINGS PAID for NICHOLSON TRAPS

ness in controlling temperature as well as draining condensate, Nicholson expansion steam traps are paying for themselves in many industries.

Nicholson expansion steam traps were installed by a processor on tank heaters and coils where various unit temperatures from 160° to 185°F had to be maintained. The steam temperature was 320°F. Figuring the difference in heat loss between Nicholson traps discharging condensate at 160° and others discharging it at approximately the steam temperature, they feel the heat loss was cut nearly in half. Due to their effective-

TYPE BF Expansion Steam Trap — Installed horizontally. Both types are for steam or hot water; pressure to 250 lbs.



TYPE SF — Installed horizontally or vertically without supports.

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Absorption Stills	Laundries	Retorts
Cookers	Molding Presses	Separators
Dry Kilns	Paper Machinery	Steam Stills
Evaporators	Pipe Coils	Sterilizers
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Heavy Oil Tanks	Railway Coaches	Wax Tanks

Catalog 751 or see Sweet's

W. H. NICHOLSON & CO.

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Representatives, in 55 Principal Cities, to Help You Solve Specification and Maintenance Problems in Traps, Floats, Control Valves

WHERE CAN YOU USE A VARIABLE VOLTAGE ADJUSTOR

• Bulletin VA-180 gives complete specifications of Acme Electric Variable Voltage Regulators in ratings from 150 watts to 10 KVA. Write for copy.

Many industrial maintenance and operating problems can be quickly solved by the installation of a Variable Voltage Adjustor to manually control a low voltage or fluctuating voltage circuit. This is particularly true where a voltage drop at electrically powered equipment, located a considerable distance from a transformer, reduces the performance, efficiency and prevents normal operation. If you have a condition like this in your plant write for Bulletin VA-180.

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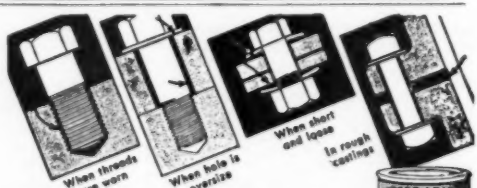
Acme ACME Electric
TRANSFORMERS



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THE IRON REPAIR CEMENT OF MANY USES

New bulletins and catalogs

(Continued from page 149)

factors and pulley diameters are listed in quick reference table form. New York Belting & Packing Co.

Pneumatic Conveyers **229**

Bulk materials handling in process industries, using suction and pressure type pneumatic conveyers, is discussed in 24-page booklet 529. Layout drawings and case histories of installations in various industries suggest applications. Accessories are also presented. Dracco Corp.

Conveyers **230**

Typical layout drawings, engineering data, calculation tables, charts and formulas for conveyer units developed for mechanical handling of bulk flowable materials are presented in 28-page booklet 2475. Units serve as self-feeding conveyers and conveyer-elevators in one fully enclosed assembly. Link-Belt Co.

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BUILDING MATERIALS & MAINTENANCE

Vibration Control **231**

Isolation pad material for control of vibration transmission is the subject of 4-page folder ER-702. Advantages, construction and engineering data are presented. Typical installations are shown. The Korfund Co., Inc.

FANS & BLOWERS

Ventilating Fans **232**

Descriptions, including specifications and dimensions, of many types of fans and blowers are presented in 30-page catalog 400. Included are industrial ventilating, vertical discharge line pressure, duct-booster, air blaster and penthouse unit fans, and multiple exhauster blower units. Engineering data on how to select and install the proper fan is included. Chelsea Fan & Blower Co., Inc.

LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Lubricants **233**

Product index for 1952, 6-page folder, is compiled as a quick reference to complete line of available processing and maintenance products, including lubricants, mechanical leathers, metal and textile oils and chemicals. Trade name and application for each product is listed. E. F. Houghton & Co.

Lubrication Systems **234**

Positive mechanical method of delivering oil or grease under pressure from a centralized station is described in 16-page bulletin 25. How the valves operate and details of manual and automatic pumps are discussed. Advantages and typical installations are presented. Fittings and accessories are listed. The Farval Corp.

(Continued on page 152)

"TOLEDO No. 999 2" POWER THREADER *a favorite with Field Superintendents!*" ... says 18-YEAR USER

KAIGHIN & HUGHES, INC.

TOLEDO 1, OHIO
March 25, 1952

The Toledo Pipe Threading Machine Company,
1445 Summit Street,
Toledo, Ohio.

Attention: Mr. Karl R. Young

Gentlemen:

We are pleased to report that our Toledo Pipe Threading Machine has given us excellent service throughout our eighteen years of mechanical contracting.

The adaptability and ruggedness of the 2" size Power Threader for field use has made this machine a favorite with our Field Superintendents. Its use in cutting, threading and reaming of pipe and threading of bolts on our many field installations, makes it popular with workmen because of the ease and rapidity of size changes with the individual quick opening die heads.

We are at present using your machine for cutting and threading 16,000 feet of 2" seamless pipe required for large box condensers which we are assembling in our fabricating plant for the chemical industry.

If this letter can be used to help others become acquainted with the many advantages of "Toledo" equipment, please feel free to use it.

Very truly yours,

KAIGHIN & HUGHES, INC.

Karl R. Kaighin

KRK:H

A pair of Toledos—No. 1-2-4 (at left) for 1" to 4" pipe; and No. 999 for up to 2" pipe—in the modern pipe shop of Kaighin & Hughes, Inc., Toledo, Ohio.

Big successful outfits like Kaighin & Hughes, Inc. are among the many users who have found TOLEDO Power Pipe Machines "tops" for *high production . . . easy operation . . . long life . . .* and *low upkeep.*

Especially popular in pipe shops or in the field— Toledo No. 999 2" Portable Power Threader! Threads 2" pipe in 22 seconds . . . cuts off in 10 seconds. *Built to last* with the rugged precision of a fine lathe. Many No. 999's in use 20 years *and more!* This means *lower monthly cost*—another advantage of Toledo dependability! Write for new catalog. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

50 Years of Leadership **TOLEDO**

PIPE TOOLS . . . POWER PIPE MACHINES . . . POWER DRIVES

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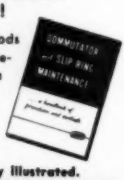
ENDS COSTLY SHUT-DOWNS of motors and generators

IDEAL PREVENTIVE MAINTENANCE

protects you against shut-downs and high cost overhauls resulting from commutator and slip ring failure. IPM keeps motors and generators at peak efficiency . . . *without dismantling*, and with only simple, routine maintenance. It insures you of using the methods and equipment that have proved most practical and economical in eliminating commonly encountered commutator and slip ring troubles. IPM has improved operating dependability and efficiency—*and reduced costs*—at many of the nation's largest users of electric motors and generators. It can do as much for you!

Get this FREE handbook of practical help!

procedures and methods developed by independent authorities on commutator and slip ring maintenance. What to do and how to do it!



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CITY_____ ZONE____ STATE____

New bulletins and catalogs

(Continued from page 151)

HEAT EXCHANGER EQUIPMENT

Cooling Towers **235**

Quick reference list of available literature on line of cooling towers and auxiliary equipment is contained in 4-page folder 1.19.092A. Types of cooling towers include mechanical draft, package type and atmospheric. Auxiliary equipment includes fans, fan drives and throats, louvers, and spray nozzles. Gas and air treating and heat exchanger equipment also are listed. J. F. Pritchard & Co.

FILTERS, STRAINERS & PURIFIERS

Filters **236**

Replaceable cartridge filters for clarification of many fluids and gases are the subject of 4-page folder PJL-0351. Details of construction, operation and application are discussed, as well as specifications and tables of capacities and dimensions. The Cuno Engineering Co.

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Twin Strainers **237**

Twin strainers for filtering foreign matter from oils, greases, tar, glue, sugar juice and similar viscous fluids are described in 4-page folder. A-17. They are available with inlet sizes from 1 through 10 in. for working pressures to 500 psi. Elliott Co., Accessories Dept.

MATERIALS OF CONSTRUCTION

Technical Handbook **238**

Compiled as a ready reference source, this 168-page leatherette-bound handbook contains considerable useful information concerning brass mill products. The manual has been revised to include the latest developments in high strength, corrosion resisting copper-base alloys. Many useful tables of engineering data are presented. Bridgeport Brass Co.

REFRACTORY CONCRETES

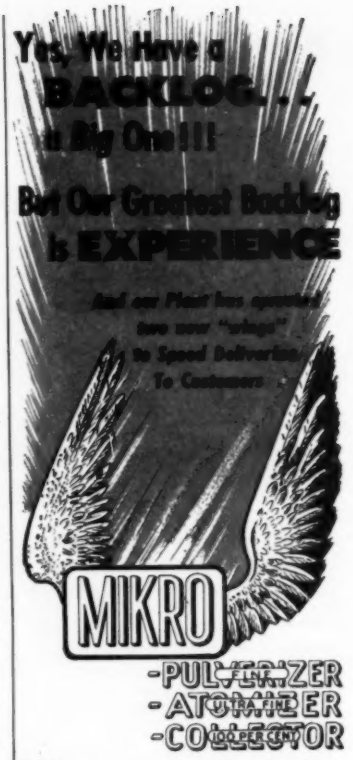
Boiler Refractories **239**

Application of monolithic refractory linings to firebox and similar types of heating boilers is discussed in 6-page bulletin 11. In addition to containing engineer's specifications for refractory linings and outside walls, typical installations are shown. Air-cooled as well as solid construction is dealt with. Pilbrico Jointless Firebrick Co.

PACKAGED STEAM GENERATORS

Unit Steam Generator **240**

Design features of unit steam generators are discussed in 28-page booklet 2000. Illustrations supplement discussions. Data and dimensions of the units are listed. Capacities are listed from 690 to 20,700 lb steam per hr. Preferred Utilities Manufacturing Corp.



We have spent more than a quarter century building up that precious backlog of experience. We have spent a minimum of 300,000 engineering and research hours seeing to it that our customers get precisely what they need—which actually means anticipating their need for improved MIKRO equipment to do an ever better job in pulverizing, liquid or dry milling, blending and industrial dust control.

Twenty-eight years on one job add up to a lot of savvy, but they don't necessarily mean hardened arteries or long whiskers. An industrial organization is as young as its dynamic enthusiasm. We haven't stopped growing. Recently we built two wings increasing production facilities by 25%.

It won't cost you anything to test our seasoned youth. If you have a grinding or dust collection problem you can't seem to lick, let our MIKRO Laboratory work on it. And by all means, drop us a line if you want the know-how.

PULVERIZING MACHINERY COMPANY
44 Chatham Road Summit, New Jersey
1907

Packaged Steam Generators **241**

Construction of packaged steam generators is described in 8-page bulletin 1050. Auxiliary equipment is listed and a blueprint, with dimensions, of a typical boiler room layout is presented. Ames Iron Works.

FUELS & FIRING EQUIPMENT

Burners **242**

Combined gas and oil burners are described and illustrated in 4-page folder 205A. Advantages and construction features are presented, along with descriptions of important working parts. Peabody Engineering Corp.

Combustion Control **243**

Described in 8-page bulletin 22 is a combustion control for regulating the fuel-air ratio of oil fired boilers. Features and advantages are discussed, and low load operation is dealt with. A schematic drawing is used to show how the unit operates. Brooke Engineering Co.

MOTORS & GENERATORS

Induction Motors **244**

Construction features, ratings and dimensions of Allis-Chalmers open drip-proof and splash-proof squirrel cage induction motors are described in 6-page folder 51B6210D. Ratings are ½ to 100 hp. Allis-Chalmers Manufacturing Co.

Variable Speed Motors **245**

Typical applications for variable speed motors are illustrated in 8-page bulletin 1551. Speeds from 1 to 10,000 rpm are listed with motors from ¼ to 50 hp. U. S. Electrical Motors, Inc.

Electrical Maintenance **246**

Electrical maintenance program based on use of genuine renewal parts, repair service plants, and engineering and field service is outlined in 24-page booklet B-4766. Available maintenance service for electrical apparatus is described. Westinghouse Electric Corp.

Induction Motors **247**

Construction features of drip- and splash-proof squirrel cage induction motors are described in 6-page folder 51B7693. Units are from 15 hp at 450 rpm to 800 hp at 3600 rpm. Allis-Chalmers Manufacturing Co.

Induction Motors **248**

Construction features of squirrel cage induction motors are described in 12-page bulletin 730. Insulation, mountings and typical applications are discussed. The Louis Allis Co.

Induction Motors **249**

Over 100 case histories telling of applications of steel frame induction motors in varied industries are depicted in 36-page booklet B-4769. Each gives problems involved, the motor choice for the job and the results. Westinghouse Electric Corp.

(Continued on page 154)

"CALL IN THE MIDGETS
for cleaning those MIGHTY IMPORTANT small tubes"
AIRETOOL'S line-up of midget cleaners provides you with just the right tools for safe, quick, thorough scale removal from condenser, heat exchanger and all other small tubes.
AIRETOOL Midget Cleaners are Right for your job!
Exponding blade type head with #29 motor
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Brush type head
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These cleaning heads can be used with either a flexible drive or universal joint for removing scale or other deposits from straight or bent tubes. Tube sizes range from ⅝" to 2" I.D. Midget motors are powerful and are air driven.
By using them regularly, you reduce down-time and add to the life and usefulness of your valuable equipment. To learn the full story, write The AIRETOOL Mfg. Co., 318 S. Center St., Springfield, Ohio.
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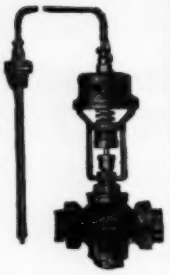
THERE'S AN AIRETOOL TUBE CLEANER AND TUBE EXPANDER FOR EVERY TYPE OF TUBULAR CONSTRUCTION

TEMPERATURE
ATLAS
REGULATORS

WHAT DO THEY DO ?



1—ATLAS Temperature Regulators continually maintain the desired temperatures of steam heated air, water, oils, or other liquids by automatically adjusting the steam supply for such heating.

2—On dry rooms they control the temperatures by operating dampers or diaphragm valves on the steam supply lines.

3—On hot water tanks they control the temperature of the water by operating diaphragm valves on the steam supply lines to the heating coils.

4—On hot water instantaneous heaters or generators they control the temperature of the water within a few degrees variation by operating, through a relay, diaphragm steam valves of any size almost instantaneously.

5—On cookers, vats, scalding or other open tanks they control the temperature by operating diaphragm valves on the steam supply lines.

6—They can be adjusted to operate at any desired temperature up to 300 deg. Fahr., and accurately hold their temperature adjustment regardless of the variation in pressure or demand for steam.

7—Each regulator will operate one or more control valves of any size from ½" to 8".

8—The diaphragm steam control valves are made suitable for any pressure from atmospheric to 250 lb. for saturated or superheated steam and are opened wide or shut off tight on a temperature variation of less than 2 degrees.

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REGULATING VALVES FOR EVERY STEAM

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☐ Thermostats
☐ Balanced Valves
☐ Control Valves
☐ Humidity Controllers

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New bulletins and catalogs

(Continued from page 153)

Gearmotors **250**

Gearmotors comprising motor and speed reducer in a single housing are described in 8-page bulletin B-601. Numerous types of speed reducers and motors are offered. Motor ratings are from ⅛ to 75 hp. Speed ratios range from 2.5:1 to 97:1. Miehle Printing Press and Manufacturing Co., Star-Kimble Motor Div.

D-C Motors **251**

Construction features for heavy duty, adjustable speed d-c motors are described in 4-page folder 8400. In ball bearing designs, the motors are available in open, drip-proof, drip proof protected and totally enclosed non-ventilated construction. Sleeve bearing designs are built in open type enclosures only. Electric Boat Co., Electro Dynamic Div.

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PIPE & FITTINGS

Expansion Joints **252**

Many styles of packless expansion joints are described in 28-page brochure 35-51A. Useful engineering data section presents table of thermal expansion for pipe as well as selection and installation data. Specifications are listed for quick reference. American District Steam Co., Inc.

Welding Fittings **253**

Facts concerning welding fittings are briefly outlined in 16-page catalog 1051. Information on physical characteristics, assembly and how to order is also presented. Specifications are listed for various stainless steel lightweight welding fittings. Tri-Clover Machine Co.

Fusion Welded Steel Pipe **254**

Advantages, methods of manufacture and specifications for fusion welded steel pipe are discussed in 6-page folder. A variety of field joints and protective coatings are available to meet specific requirements. Pipe sizes from 4 to 36 in. are listed. Southern Pipe & Casing Co.

Swivel Joints **255**

Specifications for ball-bearing swivel joints are listed in 8-page catalog 51-C. Types and materials for specific applications are included. Chiksan Co.

PUMPS

Controllable Capacity Pumps **256**

Details of construction, applications, operation and advantages for controllable capacity pumps are presented in 8-page bulletin 65A. Diagrammatic layout shows arrangement of automatic hydraulic stroke-control system for boiler feeding, oil burner supply and similar applications. The Aldrich Pump Co.

Centrifugal Pumps **257**

Pedestal and close coupled centrifugal pumps made of corrosion resistant alloys are the subject of 12 data sheets, section

Two model F-22 Syntron Feeders feeding coal from track hopper to conveyor belt in a Power Plant. These Feeders, in this particular installations, handle a carload of coal as fast as 20 minutes.

Fill Your Need For
Heavy Tonnage
Coal Handling to

Crushers, Screens, Conveyor Belts, Driers, Mullers, etc., with

SYNTRON

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VIBRATORY FEEDERS

Capacities of up to
Hundreds of Tons Per Hour
At Instantly
Controllable Rates
of Material Flow

Finger-tip dial control of rate of flow is standard on all models

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425 Lexington Ave. Homer City, Pa.

C. Mounting dimensions, cross section drawings and capacity curves are given. Sizes from 1x3¼ to 4x3 in. are listed. Ampco Metal, Inc.

Turbine Vane Pumps **258**

Self-priming, turbine vane pumps for hot and cold, clear and vaporous liquid, in moderate capacities against medium or high heads, are featured in 12-page bulletin B-2205. Descriptions together with head-capacity charts, sectional views and elevation drawings and dimensions are included. Food Machinery and Chemical Corp., Peerless Pump Div.

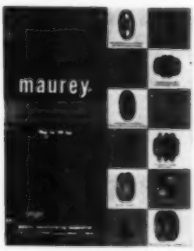
MECHANICAL POWER TRANSMISSION

Overload Cut-Outs **259**

Cut-out pulleys and couplings which instantly shut off motors when an overload occurs are discussed in 12-page bulletin 51. Units reset automatically. Engineering information for proper selection is included. Torque range is 10 to 2000 in-lb for couplings and 20 to 10,000 in-lb for pulley type. John Waldron Corp.

V-Drives **260**

Equipment for V-drives in the fractional to 10 hp range is presented in 44-page catalog f-10. Specifications for bushed and fixed bore cast iron and pressed steel V-



pulleys, V-belts, refrigeration fans and fan pulleys are listed. An engineering data section provides helpful information for the selection of the proper drive. Maurey Manufacturing Corp.

STEAM SPECIALTIES

Steam Traps **261**

Steam traps equipped with bronze, monel, or stainless steel bellows and body construction of bronze, semisteel or cast iron are featured in 12-page catalog 152. Sizes are ¼ to 2 in. for all pressures from vacuum to 300 psi. In addition to capacity tables and dimensions, recommended piping diagrams, typical applications and data concerning selection of units are included. W. H. Nicholson & Co.

TRANSFORMERS

Distribution Transformers **262**

Air-cooled distribution transformers and unit substations are described in two 4-page folders 49-ACO and 50-FC. Ratings are listed. Advantages and information on installation are discussed. Marcus Transformer Co., Inc.

Dry Type Transformers **263**

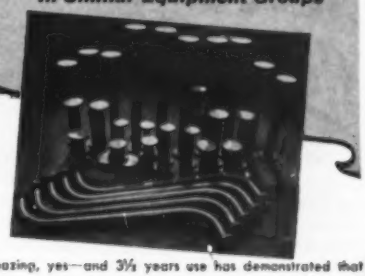
Ratings of 600 v and below, single phase, 3 to 200 kva are listed for dry type transformers featured in 4-page folder 6-01. Advantages and construction details are discussed, and table lists specifications. Magnatran Inc.

(Continued on page 157)

Pipe Cost – $1,360
Plus Installation
Savings – Every Year – $8,000
In Similar Equipment Groups

Some of the Ways we are helping others

Made furnisher rolls for printing textiles, developed non-toxic white rubber linings for food processing equipment, constructed special rolls for the new non-contact printing process, devised static absorbing rolls, and provided many other specials for troubled production executives



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Details a case history on rubber lined pipe that applies to corrosion protection in any field. You will find it a thought-provoking text that may reveal ways you can use the services of our RUBBER ENGINEERS.

Amazing, yes—and 3½ years use has demonstrated that this saving is no temporary affair.

Many case histories have proven the merit of the La Favorite method of lining and/or covering pipe, valves, tanks and special equipment with exclusive La Favorite rubber compounds.

They have confirmed the value of this method of protection against corrosion and other destructive forces.

They show that it has SAVED countless thousands of dollars for users—and that is what counts!!!

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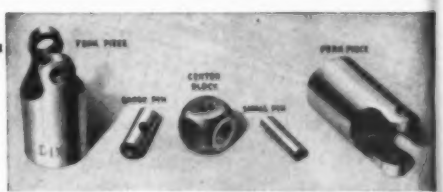
What's Your Angle . . .



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UNIVERSAL JOINTS
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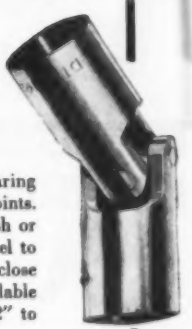

For the greatest operating angle with maximum bearing surface and strength, always use Lovejoy Universal Joints. Operation is smoother — there's no binding, backlash or end play. Precision-ground of heat-treated alloy steel to .001 concentricity. Rivets ground flush with body for close work. Exceed Armed Forces rigid requirements. Available in 13 sizes with diameters ½" to 4" and lengths 2" to 10 5/8".

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WITH WECO *Hi-Speed* SEAL

• You'll never have leaking pipe thread connections when you make them up with WECO HI-SPEED SEAL. Quickly and easily applied, HI-SPEED SEAL forms a leak-proof coating on the threads that positively prevents leaking.

HI-SPEED SEAL is a non-hardening compound that requires no thinner . . . is not affected by hot or cold weather and seals with less torque. Make all of your piping connections leak-proof by making them up with WECO HI-SPEED SEAL.

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New bulletins and catalogs

(Continued from page 155)

Variable Transformers **264**

Featured in 4-page folder P252 is a variable transformer designed for a-c voltage control applications involving 50, 100 and 150 w. Application, advantages and specifications are presented. Table lists other products including voltage regulators, power supply units, binding posts and dimmers. The Superior Electric Co.

VALVES

Air Inlet Valves **265**

Reasons for using vacuum breaking valves in thin walled pipe lines are explained in 20-page booklet 1202. Construction details, operation, valve sizes, application, dimensions and information on installation are discussed. Actual installations are shown. Condensed engineering data and charts for selection of proper sizes and required number of valves are presented. Simplex Valve & Meter Co.

HOW TO REQUEST FREE BULLETINS

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Gages & Valves **266**

Heated and cooled gages and valves built to meet special conditions are described in 4-page folder 179. Gages include internal and external models. Specifications and dimensions also are presented. Jerguson Gage & Valve Co.

Valves **267**

"Valves of Iron," 4-page folder V-405, lists general specifications for standard iron gate, globe and check valves. UL approved valves for fire line use and gate valves conforming to specifications of American Water Works Assoc. also are listed. Cutaway views show use of bronze in these valves. The Fairbanks Co.

WATER TREATMENT

Gravity Filters **268**

Information concerning gravity filters, contained in 24-page booklet 2539A, should be useful to engineers concerned with water problems. Specifications, operation, dimensions and typical installations of filters and accessories are included. Section presenting data for selection of equipment includes nomograph for selecting wash trough dimensions. The Permutit Co.

Deaerating Heaters **269**

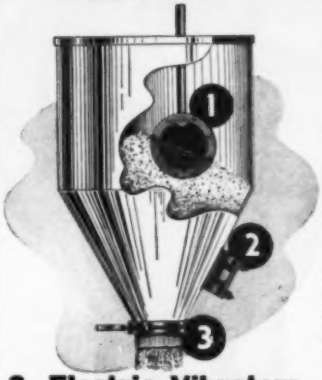
Tray and spray-tray type deaerating heaters are the subject of 12-page bu..etin WC-106. Introductory section explains principles of successful deaeration and essential elements of deaerating heaters. Features are listed in tabular form and illustrated by drawings. Included are flow diagrams and photos of typical installations. Graver Water Conditioning Co.

Industrial Waste Treatment **270**

Equipment for water, sewage and industrial waste treatment is described in 52-page catalog 533. Included are screens, grinders, dewatering conveyers, grit col-

(Continued on page 158)

for Complete Hopper Efficiency—



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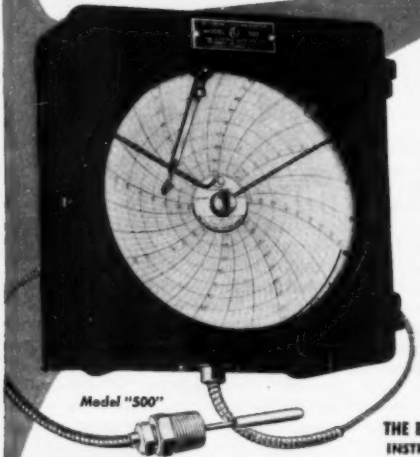

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New bulletins and catalogs

(Continued from page 157)

lectors and washers, biofiltration systems, settling tanks, scum removers and chemical feeders. Typical installations are illustrated. The Jeffrey Manufacturing Co.

Zeolite Softener **271**

Bulletin 4520-A contains explanation of zeolite water softening, including glossary of terms, data for laying out softening plant, factors governing equipment size, selection of zeolites, and description of

operating stages of a sodium zeolite softener. Description of single control valve featuring six valves in one also is included. Cochrane Corp.

Vacuum Deaerator **272**

How a vacuum deaerator removes oxyge and free carbon dioxide from water is described in 8-page bulletin 3696. Construction details and uses for the units are presented. Also described is a degasifier unit. The Permutit Co.

MISCELLANEOUS

Graphitization **273**

Research findings concerning the graphitization phenomena encountered in systems operating at elevated temperatures in the power and processing industries are reported in 12-page booklet. Preventive and corrective measures are listed. The effects of chemical composition, deoxidation practice, pre-welding microstructure, welding conditions, stress and strain also are discussed. Edward Valves, Inc.

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Wired Television **274**

Advantages of wired television in industry are discussed in 4-page folder 1025-A. Typical uses are listed, and technical information concerning camera tube is presented. Circuit design for camera, power unit and monitor are also discussed. Diamond Power Specialty Corp.

Multi-Louver Dryer **275**

Basic principles of heat drying are explained in 24-page booklet 2409, as well as other useful engineering information. In-

cluded is a 2-page psychrometric chart. Multi-louver dryers for drying, cooling and processing such bulk materials as coal, food, chemicals and fertilizers are described. Fast treatment and close temperature control is provided. Link-Belt Co.

Cleaning Service 276

Service described in 8-page bulletin offers efficient cleaning for surfaces of steam generators, heat exchange equipment, water lines and well piping, without dismantling and with minimum downtime. How the service works and photos of personnel and equipment in operation are presented. Dowell Inc.

Foundry Mechanization 277

How a foundry can be mechanized for increased production, better castings and improved working conditions is the topic of 34-page booklet 2439. Selection of actual case histories, foundry layout drawings and installation photos are presented. Link-Belt Co.

Reviews of

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Heat Engineering

As the title implies, this monthly publication furnishes 20 pages of information on many types of heat exchange apparatus. Vol. XXVII, No. 4, a typical issue, contains two boiler installation stories and an article on manifolding vaporizers. All are original articles. Should be of interest to those concerned with heat engineering. Foster Wheeler Corp., Public Relations Dept., 165 Broadway, New York 6, N. Y.

The Project Engineer

Features articles on Aerotec, Prat Daniel, Heacon and Aerotherm products. Dust collection in all its phases is thoroughly covered both from a design and application viewpoint. Vol. 11, No. 5, 8 pages, discusses the new series 4P PD tubular dust collector along with an article "Constant Current Control for Electrostatic Precipitators." The Thermix Corp., Greenwich, Conn.

Copper Alloy Bulletin

Issued monthly and gives data on copper and copper alloys. Physical and mechanical properties of specific types are listed along with application recommendations. Sheet is perforated for filing. Bridgeport Brass Co., 30 Grand St., Bridgeport, Conn.

Triangle Topics

New publication to appear six times a year and published to pass on helpful design and application data about refractory materials and construction. Vol. 1, No. 1, 8 pages, contains articles covering glass plant and steel mill refractories. Articles on other industries will appear in subsequent issues. Question and Answer Column should be of value. Laclede-Cristy Co., Arcade Bldg., 812 Olive St., St. Louis, Mo.

Dust and Fume Topics

Another new periodical which will be devoted to various dust and fume handling control problems throughout industry. Vol. I, No. 1, contains 4 pages and considers problems in lead oxide dust handling, wood dust collection, rock dust, and mica collection in roofing manufacture. Future editions will present similar data applying to other industries. American Wheelabrator & Equipment Corp., 1404 South Byrkit St., Mishawaka, Ind.

—End

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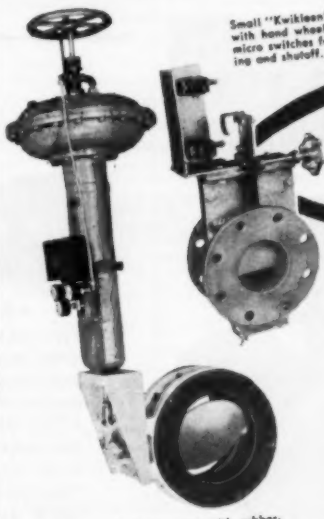

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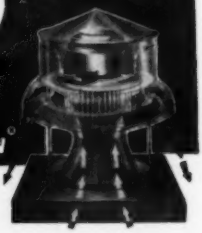

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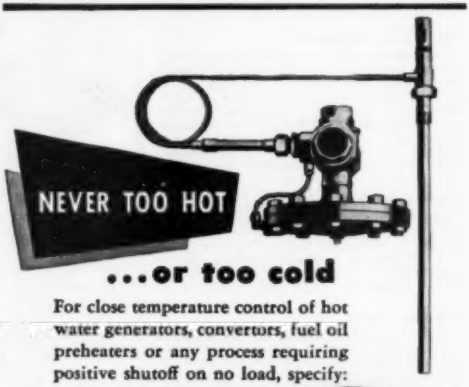

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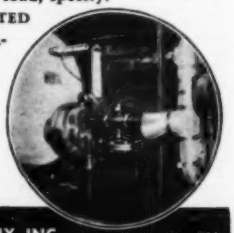

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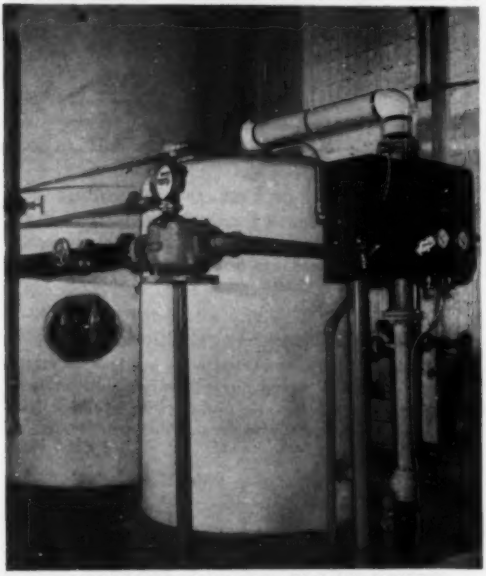

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CLAYTON 1, NEW JERSEY

INCREASE POWER CAPACITY
with absolute safety

One, two and three pole

With Heinemann Circuit Breakers, no capacity is lost because of temperature. At any room temperature, these circuit breakers allow use of your electrical system to full rated capacity with complete safety. Extra power thus available within your equipment ratings may be as much as 15%.

Heinemann Circuit Breakers do not use thermal warp elements. They operate directly on the basis of the current itself. They always carry the full rated load and momentary overloads, yet provide fastest circuit interruption available on short circuits or harmful overloads.

Know the facts . . . send for Bulletins 1010 and 1410.

don't use heat . . . *USE POWER*

HEINEMANN ELECTRIC CO.
140 Plum St., Trenton 2, N. J.

HEINEMANN *Circuit breakers*

FLEXIBLE METAL HOSE *Armored* FOR YOUR PROTECTION

"TEST HOSE TO FOUR TIMES SPECIFICATIONS" is standard procedure with every length of Atlantic flexible metal hose.

17 rigorous torture tests for flexibility, bursting pressure and uniformity reveal any material or fabricating fault. That's why Atlantic flexible metal hose is Job *Tested & Guaranteed to Do Its Job!*

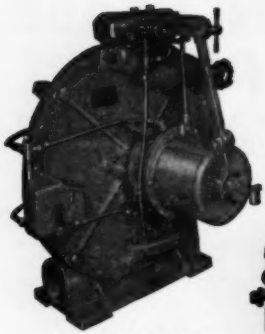
Seamless & Interlocking Hose.
Bronze, steel, stainless steel.
⅛"-36" I.D. with proper fittings.

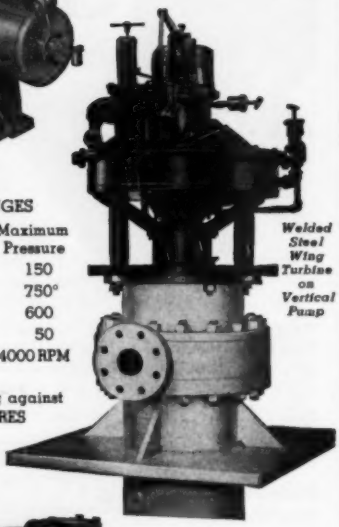
Write for Catalog 580

See Our Catalogs in Sweet's Files For Product Designers and Mechanical Industries

ATLANTIC METAL HOSE CO., INC.
124 West 64th St., New York 23, N. Y.

WING AUXILIARY TURBINES





Welded Steel Wing Turbine on Vertical Pump

OPERATING RANGES

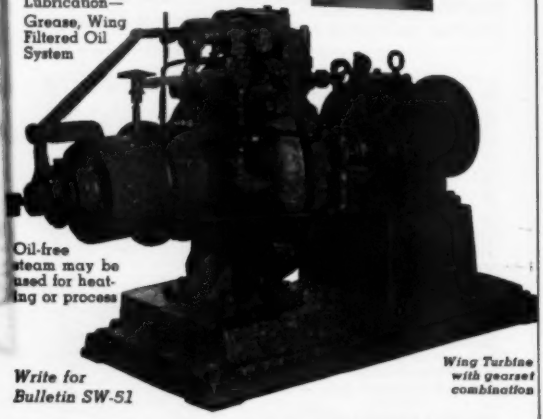
	Standard	Maximum Pressure
Horsepowers	100	150
Temperatures	525°	750°
Pressures	275	600
Back Pressures	50	50
Speeds	4000 RPM	4000 RPM

Capable of exhausting against HIGH BACK PRESSURES

Shafts—Horizontal or vertical

Rotation—Clockwise or counter-clockwise

Lubrication—Grease, Wing Filtered Oil System



Oil-free steam may be used for heating or process

Wing Turbine with gearset combination

Write for Bulletin SW-51

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Factories: Linden, N. J., Montreal, Canada

Wing AUXILIARY STEAM TURBINES

PROFIT by the EXPERIENCE of America's FINEST PLANTS

They REPEAT-ORDER

HOFFMAN *Heavy-Duty*

VACUUM CLEANING EQUIPMENT for Wider Range Dust Removal!

One installation sells another, as plant after plant finds that Hoffman vacuum cleaning units save labor—salvage material—reduce product defects—eliminate dust hazards. They've proved that they can clean larger areas of walls, floors and overhead surface with Hoffman equipment. Built to provide bigger capacity, higher vacuum and long years of service on the most grueling plant cleaning jobs.

YOUR CHOICE OF 4 BIG-CAPACITY PORTABLES

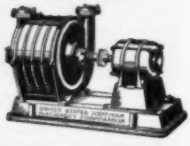
Advanced design and construction features for fast, efficient cleaning, with one-man handling. 1½, 3, 5, and 7½ H.P. models to match your specific cleaning requirements

STATIONARY SYSTEMS IN A WIDE RANGE OF SIZES TO FIT YOUR MAINTENANCE OR PRODUCTION OPERATIONS

Provides cleaning in several areas at the same time. Sweepers attach cleaning hose to conveniently located inlets (in a permanently piped system). Dust is removed pneumatically to central collectors for easy disposal.

MULTISTAGE CENTRIFUGAL BLOWERS AND EXHAUSTERS

For agitation of liquids, combustion, mixing—for all air requirements (including the elimination of compressed air). No internal moving parts. Low power consumption. Adopted as standard in steel plants, textile and ice plants requiring 24-hour continuous service. Wide range of pressures, capacities and vacuum, for air or gas. Tell us your requirements.



AIR APPLIANCE DIVISION U.S. HOFFMAN MACHINERY CORPORATION

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CANADIAN PLANT: CANADIAN HOFFMAN MACHINERY CO. LTD., NEWMARKET, ONT.

Ground was broken April 15, 1951. The first Union Boiler went on the line Oct. 15, 1951 and the other three were in full operation Dec. 15, 1951.

Fish Canners Co-op.

Specify UNION *at* TERMINAL ISLAND Los Angeles, California

Five independent fish canneries on Terminal Island, Los Angeles, California chose 4 "H" Type Union Steam Generators to furnish the steam for their cooperative steam plant. Each boiler has a continuous duty rating of 80,000 lb. per hour and each can produce 100,000 lb. per hour during 4 hour peak demand periods. Firing with natural gas or Bunker C oil is optional on 15 minutes notice. Flexibility of firing method and steam control is of utmost importance in supplying the steam for fish canneries as the size of the catch determines the demand on the steam generators. Latest performance reports since completion of installation Dec. 15, 1951 show that guaranteed efficiency of 80.11% at a rating of 100,000 lb. per hour has been exceeded.

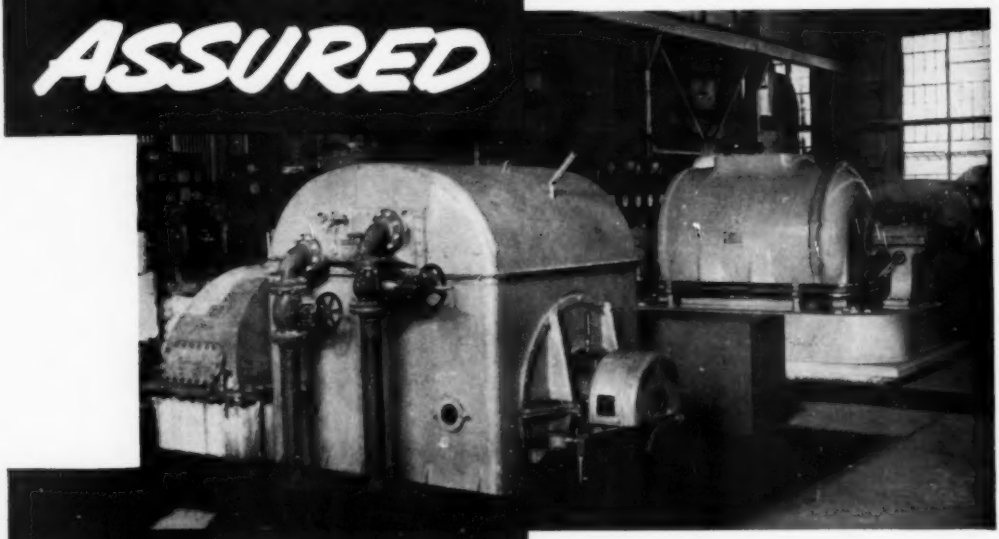
UNION IRON WORKS . . . *Since 1890*

373 CASCADE STREET • ERIE, PENNA.

BOILERS • PROCESS EQUIPMENT • FABRICATED STEEL

Dependable Performance ASSURED

TOWN OF GALLUP (N. M.) ELECTRIC POWER PLANT is 100% Texaco-lubricated. These two General Electric turbines — 4600 KW and 1800 KW — have been lubricated with Texaco *Regal Oil B (R & O)* ever since they went on the line.



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Texaco Regal Oil (R&O) is made from the same fine stocks as the Texaco Regal Oil that has been world-famous for more than 20 years. Special Texaco additives, however, give *Texaco Regal Oil (R&O) more than ten times as much oxidation resistance* and vastly increased rust-inhibiting power. Special processing prevents harmful foaming.

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FOR ALL TURBINES

Faithfully yours 50 *for Fifty Years*